

3.4 POLLUTION CONTROLS

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

3.5 SELECTIVE DEMOLITION

- A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition work above each floor or tier before disturbing supporting members on lower levels.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 - 5. Maintain adequate ventilation when using cutting torches.
 - 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 - 8. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 9. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.
 - 10. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.
- B. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- C. Remove existing stone masonry at foundation by hand. Stack stones on site with the original exteriors facing out. Salvage for reuse.
- C. Remove no more existing roofing than can be covered in one day by new roofing. See applicable Division-7 Section for new roofing requirements.

3.6 PATCHING AND REPAIRS

- A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.
- B. Patching is specified in Division 1 Section "Cutting and Patching."
- C. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
- D. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.
- E. Patch and repair floor and wall surfaces in the new space where demolished walls or partitions extend one finished area into another. Provide a flush and even surface of uniform color and appearance.
 - 1. Closely match texture and finish of existing adjacent surface.
 - 2. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
 - 3. Where patching smooth painted surfaces, extend final paint coat over entire unbroken surface containing the patch after the surface has received primer and second coat.
 - 4. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - 5. Inspect and test patched areas to demonstrate integrity of the installation, where feasible.
- F. Patch, repair, or re-hang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site. Remove debris daily from the site.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them. The disposal of any materials removed by the contractor must be in compliance with all building codes, local, city, state and federal requirements.

3.8 TRAFFIC CONTROL

- A. Provide barriers and signs as recommended by the Owner's Representative for controlling traffic during demolition operations.

3.9 FIRE PROTECTION

- A. Provide fire-extinguishing equipment as recommended by NFPA and as required by OSHA. Provide a minimum of one "Type A" extinguisher in Field Office and one "Type ABC" on each building level in demolition and construction areas; locate extinguishers near entrances and stairways.
- B. Where electric or gas welding and cutting work, or other open flame is used above, below, or within 10' of combustible material, shields of incombustible materials are to be placed to protect against fire damage or injury due to sparks and hot metal. No work of this kind may be performed without a burn permit being issued.

- C. Gas storage tanks for welding and cutting shall be positioned at no greater distance from the work than is necessary for safety and shall be securely fastened and maintained in an upright position. Tanks shall be stored remote from combustible materials, and free from exposure to the sun or high temperatures.
- D. Suitable fire extinguishing equipment shall be in position near all welding or cutting operations. When work ceases for an extended period such as the noon hour, or at the end of the day, the area adjacent to the welding or cutting operation shall be thoroughly wet down. A workman shall be stationed near the welding or cutting operation to check for sparks lodging in cracks or combustible material while operation is in progress, and shall remain for at least 2 hours after operation is complete to ensure no smoldering fires have been started. As an option, cease all welding or cutting work at least 2 hours prior to end of workday to allow sufficient time for fire watch.

3.10 CLEANING

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

END OF SECTION 024113

SECTION 02833 - LEAD-BASED PAINT MANAGEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies abatement and disposal of lead-based paint (LBP) and controls needed to limit occupational and environmental exposure to lead hazards. Contractor to manage the work on the elements of the building painted with lead-based paint according to current rules and regulations.

1.2 RELATED WORK

- A. Section 024113, Selective Demolition.
- B. Section 099000, Painting.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. Code of Federal Regulations (CFR):
 - CFR 29 Part 1910.....Occupational Safety and Health Standards
 - CFR 29 Part 1926.....Safety and Health Regulations for Construction
 - CFR 40 Part 148.....Hazardous Waste Injection Restrictions
 - CFR 40 Part 260.....Hazardous Waste Management System: General
 - CFR 40 Part 261.....Identification and Listing of Hazardous Waste
 - CFR 40 Part 262.....Standards Applicable to Generators of Hazardous Waste
 - CFR 40 Part 263.....Standards Applicable to Transporters of Hazardous Waste
 - CFR 40 Part 264.....Standards for Owners and Operations of Hazardous Waste Treatment, Storage, and Disposal Facilities
 - CFR 40 Part 265.....Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
 - CFR 40 Part 268.....Land Disposal Restrictions
 - CFR 49 Part 172.....Hazardous Material Table, Special Provisions, Hazardous Material Communications, Emergency Response Information, and Training Requirements
 - CFR 49 Part 178.....Specifications for Packaging
- C. National Fire Protection Association (NFPA):
 - NFPA 701-2004.....Methods of Fire Test for Flame-Resistant Textiles and Films
- D. National Institute for Occupational Safety And Health (NIOSH)
 - NIOSH OSHA Booklet 3142. Lead in Construction
- E. Underwriters Laboratories (UL)
 - UL 586-1996 (Rev 2004).. High-Efficiency, Particulate, Air Filter Units
- F. American National Standards Institute
 - Z9.2-2001.....Fundamentals Governing the Design and Operation of Local Exhaust Systems
 - Z88.2-1992.....Respiratory Protection

1.4 DEFINITIONS

- A. Action Level: Employee exposure, without regard to use of respirations, to an airborne concentration of lead of 30 micrograms per cubic meter of air

averaged over an 8-hour period. As used in this section, "30 micrograms per cubic meter of air" refers to the action level.

- B. Area Monitoring: Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations which may reach the breathing zone of personnel potentially exposed to lead.
- C. Physical Boundary: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area."
- D. Certified Industrial Hygienist (CIH): As used in this section, refers to an Industrial Hygienist employed by the Contractor and is certified by the American Board of Industrial Hygiene in comprehensive practice.
- E. Change Rooms and Shower Facilities: Rooms within the designated physical boundary around the lead control area equipped with separate storage facilities for clean protective work clothing and equipment and for street clothes which prevent cross- contamination.
- F. Competent Person: A person capable of identifying lead hazards in the work area and is authorized by the contractor to take corrective action.
- G. Decontamination Room: Room for removal of contaminated personal protective equipment (PPE).
- H. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.
- I. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.
- J. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.
- K. Lead Control Area: An enclosed area or structure with full containment to prevent the spread of lead dust, paint chips, or debris of lead-containing paint removal operations. The lead control area is isolated by physical boundaries to prevent unauthorized entry of personnel.
- L. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1910.1025. If an employee is exposed for more than 8 hours in a work day, the PEL shall be determined by the following formula. $PEL (\text{micrograms/cubic meter of air}) = 400/\text{No. of hrs worked per day}$
- M. Personnel Monitoring: Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1910.1025. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 150 mm to 225 mm (6 to 9 inches) and the center at the nose or mouth of an employee.

1.5 QUALITY ASSURANCE

- A. Before exposure to lead-contaminated dust, provide workers with a comprehensive medical examination as required by 29 CFR 1926.62 (I) (1) (i) & (ii). The examination shall not be required if adequate records show that

- employees have been examined as required by 29 CFR 1926.62(I) without the last year.
- B. Medical Records: Maintain complete and accurate medical records of employees in accordance with 29 CFR 1910.20.
 - C. CIH Responsibilities: The Contractor shall employ a certified Industrial Hygienist who will be responsible for the following:
 - 1. Certify Training.
 - 2. Review and approve lead-containing paint removal plan for conformance to the applicable referenced standards.
 - 3. Inspect lead-containing paint removal work for conformance with the approved plan.
 - 4. Direct monitoring.
 - 5. Ensure work is performed in strict accordance with specifications at all times.
 - 6. Ensure hazardous exposure to personnel and to the environment are adequately controlled at all times.
 - D. Training: Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment, in accordance with 29 CFR 1926.62.
 - E. Training Certification: Submit certificates signed and dated by the CIH and by each employee stating that the employee has received training.
 - F. Respiratory Protection Program:
 - 1. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every 6 months thereafter as required by 29 CFR 1926.62.
 - 2. Establish and implement a respiratory protection program as required by 29 CFR 1910.134, 29 CFR 1910.1025, and 29 CFR 1926.62.
 - G. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1910.1200.
 - H. Hazardous Waste Management: The Hazardous Waste Management plan shall comply with applicable requirements of Federal, State, and local hazardous waste regulations and address:
 - 1. Identification of hazardous wastes associated with the work.
 - 2. Estimated quantities of wastes to be generated and disposed of.
 - 3. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and a 24-hour point of contact. Furnish two copies of state and local hazardous waste permit applications permits and EPA Identification numbers.
 - 4. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
 - 5. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
 - 6. Spill prevention, containment, and cleanup contingency measures to be implemented.
 - 7. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
 - 8. Cost for hazardous waste disposal according to this plan.
 - I. Safety and Health Compliance:
 - 1. In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, state, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1910.1025. Submit matters

regarding interpretation of standards to the Contracting Officer for resolution before starting work.

2. Where specification requirements and the referenced documents vary, the most stringent requirements shall apply.

J. Pre-Construction Conference: Along with the CIH, meet with the Contracting Officer to discuss in detail the lead-containing paint removal work plan, including work procedures and precautions for the work plan.

1.6 SUBMITTALS

- A. Submit the following in accordance with Section 01001, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Catalog Data:
Vacuum filters
Respirators
- C. Instructions: Paint removal materials. Include applicable material safety data sheets.
- D. Statements Certifications and Statements:
 1. Qualifications of CIH: Submit name, address, and telephone number of the CIH selected to perform responsibilities in paragraph entitled "CIH Responsibilities." Provide previous experience of the CIH. Submit proper documentation that the Industrial Hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification.
 2. Testing Laboratory: Submit the name, address, and telephone number of the testing laboratory selected to perform the monitoring, testing, and reporting of airborne concentrations of lead. Provide proper documentation that persons performing the analysis have been judged proficient by successful participation within the last year in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program. The laboratory shall be accredited by the American Industrial Hygiene Association (AIHA). Provide AIHA documentation along with date of accreditation/reaccreditation.
 3. Lead-Containing Paint Removal Plan:
 - a. Submit a detailed job-specific plan of the work procedures to be used in the removal of lead-containing paint. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination rooms, change rooms, shower facilities, and mechanical ventilation system.
 - b. Include in the plan, eating, drinking, smoking and restroom procedures, interface of trades, sequencing of lead related work, collected wastewater and paint debris disposal plan, air sampling plan, respirators, protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air are not exceeded outside of the lead control area.
 - c. Include air sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of air monitoring personnel in the air sampling portion on the plan.
 4. Field Test Reports: Monitoring Results: Submit monitoring results to the Contracting Officer within 3 working days, signed by the testing laboratory employee performing the air monitoring, the employee that analyzed the sample, and the CIH.
 5. Records:
 - a. Completed and signed hazardous waste manifest from treatment or disposal facility.
 - b. Certification of Medical Examinations.
 - c. Employee training certification.

PART 2 PRODUCTS

PAINT REMOVAL PRODUCTS: Submit applicable Material Safety Data Sheets for paint removal products used in paint removal work. Use the least toxic product, suitable for the job and acceptable to the Industrial Hygienist.

PART 3 EXECUTION

3.1 PROTECTION

- A. Notification: Notify the Contracting Officer 20 (twenty) days prior to the start of any paint removal work.
- B. Lead Control Area Requirements.
 - 1. Establish a lead control area by completely enclosing with containment screens the area or structure where lead-containing paint removal operations will be performed.
 - 2. Contain removal operations by the use of a negative pressure full containment system with at least one change room and with HEPA filtered exhaust.
- C. Protection of Existing Work to Remain: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition.
- D. Boundary Requirements: Provide physical boundaries around the lead control area by roping off the area [designated on the drawings] or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
- E. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6-mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area.
- F. Change Room and Shower Facilities: Provide clean change rooms and shower facilities within the physical boundary around the designated lead control area in accordance with requirements of 29 CFR 1926.62.
- G. Mechanical Ventilation System:
 - 1. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.57.
 - 2. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the industrial hygienist. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.
 - 3. If air from exhaust ventilation is recirculated into the work place, the system shall have a high efficiency filter with reliable back-up filter and controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails. Air may be recirculated only where exhaust to the outside is not feasible.
- H. Personnel Protection: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been given appropriate training and protective equipment.
- I. Warning Signs: Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take

the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.

3.2 WORK PROCEDURES

- A. Perform removal of lead-containing paint in accordance with approved lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-containing paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, state, and local requirements.
- B. Personnel Exiting Procedures:
 1. Whenever personnel exist the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:
 - a. Vacuum themselves off.
 - b. Remove protective clothing in the decontamination room, and place them in an approved impermeable disposal bag.
 - c. Shower.
 - d. Change to clean clothes prior to leaving the physical boundary designated around the lead-contaminated job site.
- C. Monitoring: Monitoring of airborne concentrations of lead shall be in accordance with 29 CFR 1910.1025 and as specified herein. Air monitoring, testing, and reporting shall be performed by a CIH or an Industrial Hygiene (IH) Technician who is under the direction of the CIH:
 1. The CIH or the IH Technician under the direction of the CIH shall be on the job site directing the monitoring, and inspecting the lead-containing paint removal work to ensure that the requirements of the Contract have been satisfied during the entire lead-containing paint removal operation.
 2. Take personal air monitoring samples on employees who are anticipated to have the greatest risk of exposure as determined by the CIH. In addition, take air monitoring samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
 3. Submit results of air monitoring samples, signed by the CIH, within 24 hours after the air samples are taken. Notify the Contracting Officer immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
- D. Monitoring During Paint Removal Work:
 1. Perform personal and area monitoring during the entire paint removal operation. Sufficient area monitoring shall be conducted at the physical boundary to ensure unprotected personnel are not exposed above 30 micrograms per cubic meter of air at all times. If the outside boundary lead levels are at or exceed 30 micrograms per cubic meter of air, work shall be stopped and the CIH shall immediately correct the condition(s) causing the increased levels and notify the Contracting Officer immediately.
 2. The CIH shall review the sampling data collected on that day to determine if condition(s) requires any further change in work methods. Removal work shall resume when approval is given by the CIH. The Contractor shall control the lead level outside of the work boundary to less than 30 micrograms per cubic meter of air at all times. As a minimum, conduct area monitoring daily on each shift in which lead paint removal operations are performed in areas immediately adjacent to the lead control area.
 3. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area. If adjacent areas are

contaminated, clean and visually inspect contaminated areas. The CIH shall certify that the area has been cleaned of lead contamination.

3.3 LEAD-CONTAINING PAINT REMOVAL

- A. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions are necessary to minimize damage to the underlying substrate.
- B. Indoor Lead Paint Removal: Select paint removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. This paint removal process should be described in the lead-containing paint removal plan. Perform manual sanding and scraping to the maximum extent feasible.
- C. Mechanical Paint Removal and Blast Cleaning: Perform mechanical paint removal and blast cleaning in lead control areas using negative pressure full containments with HEPA filtered exhaust. Collect paint residue and spent grit (used abrasive) from blasting operations for disposal in accordance with EPA, state and local requirements.
- D. Outside Lead Paint Removal: Select removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. This paint removal process should be described in the lead-containing paint removal plan. Perform manual sanding and scraping to the maximum extent feasible.

3.4 SURFACE PREPARATIONS

Avoid flash rusting or other deterioration of the substrate. Provide surface preparations for painting in accordance with Section 09900, painting.

3.5 CLEANUP AND DISPOSAL

- A. Cleanup: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner and wet mopping the area.
- B. Certification: The CIH shall certify in writing that the inside and outside the lead control area air monitoring samples are less than 30 micrograms per cubic meter of air, the respiratory protection for the employees was adequate, the work procedures were performed in accordance with 29 CFR 1926.62, and that there were no visible accumulations of lead-contaminated paint and dust on the worksite. Do not remove the lead control area or roped-off boundary and warning signs prior to the Contracting Officer's receipt of the CIH's certification. Reclean areas showing dust or residual paint chips.
- C. Testing of Lead-Containing Paint Residue and Used Abrasive Where indicated or when directed by the Contracting Officer, test lead containing paint residue and used abrasive in accordance with 40 CFR 261 for hazardous waste.
- D. Disposal:
 - 1. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing, which may produce airborne concentrations of lead particles.
 - 2. Store removed paint, lead-contaminated clothing and equipment, and lead-contaminated dust and cleaning debris into U.S. Department of

Transportation (49 CFR 178) approved 55-gallon drums. Properly labels each drum to identify the type of waste (49 CFR 172) and the date lead-contaminated wastes were first put into the drum. Obtain and complete the Uniform Hazardous Waste Manifest forms from approved disposal site. Comply with land disposal restriction notification requirements as required by 40 CFR 268:

- a. At least 14 days prior to delivery, notify the Contracting Officer who will arrange for job site inspection of the drums and manifests by PWC Hazardous Waste Storage Facility personnel.
 - b. As necessary, make lot deliveries of hazardous wastes to the PWC Hazardous Waste Storage Facility to ensure that drums do not remain on the jobsite longer than 90 calendar days from the date affixed to each drum.
 - a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62. Dispose of lead-contaminated waste material at a state approved hazardous waste treatment, storage, or disposal facility off Government property.
 - b. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55-gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The Contracting Officer or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.
 - c. Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
- E. Disposal Documentation Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and state or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.

END OF SECTION 028330

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
- B. Cast-in-place concrete includes the following:
 - 1. Installation of new ramp at Patterson St. entry.

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by Architect.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
 - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
 - 1. Use one brand of cement throughout Project unless otherwise acceptable to Architect.
- B. Fly Ash: ASTM C 618, Type F.
- C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.
 - 1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
 - 2. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Architect.
- D. Water: Potable.

- G. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.
- H. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Air-Tite, Cormix Construction Chemicals.
 - b. Air-Mix or Perma-Air, Euclid Chemical Co.
 - c. Darex AEA or Daravair, W.R. Grace & Co.
 - d. MB-VR or Micro-Air, Master Builders, Inc.
 - e. Sealtight AEA, W.R. Meadows, Inc.
 - f. Sika AER, Sika Corp.
- I. Water-Reducing Admixture: ASTM C 494, Type A.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Chemtard, ChemMasters Corp.
 - b. PSI N, Cormix Construction Chemicals.
 - c. Eucon WR-75, Euclid Chemical Co.
 - d. WRDA, W.R. Grace & Co.
 - e. Pozzolith Normal or Polyheed, Master Builders, Inc.
 - f. Metco W.R., Metalcrete Industries.
 - g. Prokrete-N, Prokrete Industries.
 - h. Plastocrete 161, Sika Corp.
- J. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Super P, Anti-Hydro Co., Inc.
 - b. Cormix 200, Cormix Construction Chemicals.
 - c. Eucon 37, Euclid Chemical Co.
 - d. WRDA 19 or Daracem, W.R. Grace & Co.
 - e. Rheobuild or Polyheed, Master Builders, Inc.
 - f. Superslump, Metalcrete Industries.
 - g. PSPL, Prokrete Industries.
 - h. Sikament 300, Sika Corp.
- K. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Q-Set, Conspec Marketing & Manufacturing Co.
 - b. Lubricon NCA, Cormix Construction Chemicals.
 - c. Accelguard 80, Euclid Chemical Co.
 - d. Daraset, W.R. Grace & Co.
 - e. Pozzutec 20, Master Builders, Inc.
 - f. Accel-Set, Metalcrete Industries.
- L. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. PSI-R Plus, Cormix Construction Chemicals.
 - b. Eucon Retarder 75, Euclid Chemical Co.
 - c. Daratard-17, W.R. Grace & Co.

- d. Pozzolith R, Master Builders, Inc.
- e. Protard, Prokrete Industries.
- f. Plastiment, Sika Corporation.

2.2 RELATED MATERIALS

- A. Sand Cushion: Clean, manufactured or natural sand.
- G. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:
 - 1. Polyethylene sheet not less than 8 mils thick.
- K. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- L. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
 - 1. Waterproof paper.
 - 2. Polyethylene film.
 - 3. Polyethylene-coated burlap.
- N. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.
 - 1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.
 - 2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Highseal, Conspec Marketing and Mfg. Co.
 - b. Sealco - VOC, Cormix Construction Chemicals.
 - c. Safe Cure and Seal, Dayton Superior Corp.
 - d. Aqua-Cure, Euclid Chemical Co.
 - e. Dress & Seal WB, L&M Construction Chemicals, Inc.
 - f. Masterkure 100W, Master Builders, Inc.
 - g. Vocomp-20, W.R. Meadows, Inc.
 - h. Metcure, Metalcrete Industries.
 - i. Stontop CS1, Stonhard, Inc.
- O. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Aquafilm, Conspec Marketing and Mfg. Co.
 - b. Eucobar, Euclid Chemical Co.
 - c. E-Con, L&M Construction Chemicals, Inc.
 - d. Confilm, Master Builders, Inc.
 - e. Waterhold, Metalcrete Industries.
- P. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from 1 inch thick to feathered edges.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. K-15, Ardex, Inc.
 - b. Self-Leveling Wear Topping, W.R. Bonsal Co.
 - c. Conflow, Conspec Marketing and Mfg. Co.

- d. Corlevel, Cormix Construction Chemicals.
- e. LevelLayer II, Dayton Superior Corp.
- f. Flo-Top, Euclid Chemical Co.
- g. Gyp-Crete, Gyp-Crete Corp.
- h. Levellex, L&M Construction Chemicals, Inc.
- i. Underlayment 110, Master Builders, Inc.
- j. Stoncrete UL1, Stonhard, Inc.
- k. Concrete Top, Symons Corp.
- l. Thoro Underlayment Self-Leveling, Thoro System Products.

Q. Bonding Agent: Polyvinyl acetate or acrylic base.

- 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Polyvinyl Acetate (Interior Only):
 - 1) Superior Concrete Bonder, Dayton Superior Corp.
 - 2) Euco Weld, Euclid Chemical Co.
 - 3) Weld-Crete, Larsen Products Corp.
 - 4) Everweld, L&M Construction Chemicals, Inc.
 - 5) Herculox, Metalcrete Industries.
 - 6) Ready Bond, Symons Corp.
 - b. Acrylic or Styrene Butadiene:
 - 1) Acrylic Bondcrete, The Burke Co.
 - 2) Strongbond, Conspec Marketing and Mfg. Co.
 - 3) Day-Chem Ad Bond, Dayton Superior Corp.
 - 4) SBR Latex, Euclid Chemical Co.
 - 5) Daraweld C, W.R. Grace & Co.
 - 6) Hornweld, A.C. Horn, Inc.
 - 7) Everbond, L&M Construction Chemicals, Inc.
 - 8) Acryl-Set, Master Builders Inc.
 - 9) Intralok, W.R. Meadows, Inc.
 - 10) Acrylpave, Metalcrete Industries.
 - 11) Sonocrete, Sonneborn-Chemrex.
 - 12) Stonlock LB2, Stonhard, Inc.
 - 13) Strong Bond, Symons Corp.

R. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.

- 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Burke Epoxy M.V., The Burke Co.
 - b. Spec-Bond 100, Conspec Marketing and Mfg. Co.
 - c. Resi-Bond (J-58), Dayton Superior.
 - d. Euco Epoxy System #452 or #620, Euclid Chemical Co.
 - e. Epoxite Binder 2390, A.C. Horn, Inc.
 - f. Epabond, L&M Construction Chemicals, Inc.
 - g. Conpressive Standard Liquid, Master Builders, Inc.
 - h. Rezi-Weld 1000, W.R. Meadows, Inc.
 - i. Metco Hi-Mod Epoxy, Metalcrete Industries.
 - j. Sikadur 32 Hi-Mod, Sika Corp.
 - k. Stonset LV5, Stonhard, Inc.
 - l. R-600 Series, Symons Corp.

2.3 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

1. Do not use the same testing agency for field quality control testing.
 2. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect.
- C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
1. 3000-psi, 28-day compressive strength; water-cement ratio, 0.55 maximum (non-air-entrained), 0.45 maximum (air-entrained).
 2. 4000 psi, 28 day compressive strength; water-cement ratio, 0.44 maximum (non-air-entrained), 0.35 maximum (air-entrained).
- D. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:
1. Subjected to freezing and thawing: W/C 0.45.
 2. Subjected to deicers/watertight: W/C 0.40.
 3. Subjected to brackish water, salt spray, or deicers: W/C 0.40.
- E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
 2. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.
 3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2-to-3-inch slump concrete.
 4. Other concrete: Not more than 4 inches.
- F. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in Work.

2.4 ADMIXTURES

- A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
- B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
- C. Use high-range water-reducing admixture in pumped concrete, concrete required to be watertight, and concrete with water-cement ratios below 0.50.
- D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:

- a. 4.5 percent (moderate exposure); 5.5 percent (severe exposure) for 1-1/2-inch maximum aggregate.
 - b. 4.5 percent (moderate exposure); 6.0 percent (severe exposure) for 1-inch maximum aggregate.
 - c. 5.0 percent (moderate exposure); 6.0 percent (severe exposure) for 3/4-inch maximum aggregate.
 - d. 5.5 percent (moderate exposure); 7.0 percent (severe exposure) for 1/2-inch maximum aggregate.
2. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.
- E. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

2.5 CONCRETE MIXING

- A. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.
- C. During hot weather, or under conditions contribution to rapid setting of concrete, a shorter mixing time that specified in ASTM C 94 may be required.
- D. Job-Site Mixing: Mix concrete materials in appropriate drum-type batch machine mixer. For mixers of 1 cu. yd. or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than 1 cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms.

3.2 FORMS

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.
- B. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

- E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Form Ties: Factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.
 - 1. Unless otherwise indicated, provide ties so portion remaining within concrete after removal is at least 1-1/2" inside concrete.
 - 2. Unless otherwise shown, provide form ties which will not leave holes larger than 1" diameter in concrete surface.
- H. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.
- I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retighten forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.3 PLACING REINFORCEMENT:

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
- D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.4 JOINTS

- A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.
- D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

- F. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as sidewalks, foundation walls, and other locations, as indicated.
1. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."
- G. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab depth or inserts 1/4 inch wide by one-fourth of slab depth, unless otherwise indicated.
1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
 2. Contraction joints may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
 3. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
 4. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

3.5 INSTALLING EMBEDDED ITEMS

- A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.
- D. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.6 PREPARING FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form coating compound before placing reinforcement.
- B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

3.7 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section

cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

- D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position on chairs during concrete placement.

3.8 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting bed for tile, and other bonded applied cementitious finish flooring material, and as otherwise indicated.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified.
1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, tile, paint, or other thin film finish coating system.
2. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of FF 20 - FL 17. Grind smooth surface defects which would telegraph through applied floor covering system.
- D. Trowel and Fine Broom Finish: Where ceramic tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.
- E. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete steps, sloped walks and elsewhere as indicated
1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to

main traffic route. Coordinate required final finish with Architect before application.

3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

3.10 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
- D. Provide moisture curing by the following methods:
 - 1. Keep concrete surface continuously wet by covering with water.
 - 2. Use continuous water-fog spray.
 - 3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
- E. Provide moisture-retaining cover curing as follows:
 - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- F. Provide curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs, as follows:
 - 1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall with 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
- G. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.
 - 1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

3.11 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.
- B. Mix dry-pack mortar, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
 2. For surfaces exposed to view, blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent, but do not fill tie holes where designated on site plan.
1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.
 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as

adjacent concrete.

- E. Repair isolated random cracks and single holes 1 inch or less in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Place dry-pack before bonding agent has dried. Compact Dry-Pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- F. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive and mortar.
- G. Repair methods not specified above may be used, subject to acceptance of Architect.

3.12 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Owner will employ a testing agency to perform tests and to submit test reports.
- B. Sampling and testing for quality control during concrete placement may include the following, as directed by Architect.
 - 1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
 - d. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 - 2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
 - 3. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
 - 4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 - 5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength

test result falls below specified compressive strength by more than 500 psi.

- C. Test results will be reported in writing to Architect, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION 033000

SECTION 042515 - MASONRY WORK AND REPAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Repairing, repointing and replacing damaged brick on parapet above 2nd floor ceiling line.
 - 2. Infill of existing fan opening in gym.
 - 3. Miscellaneous masonry work including cutting and patching openings for HVAC or electrical work, including lintels sized for openings needed.
 - 4. Miscellaneous masonry repairs related to door and window opening repairs.
 - 5. Repairs to the stone coping while reroofing.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Flashing and Sheet Metal" for metal flashing for restored clay masonry construction.

1.3 DEFINITIONS

- A. Repointing: The process of raking out (removing) mortar and replacing it with new mortar.
- B. Pointing: The process of placing new mortar in existing joint spaces, which have previously been raked out. This term does not include the raking out process.
- C. Tuckpointing: The process of touching up existing mortar joints by filling in recesses with new mortar, without first raking out the joints.

1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each product indicated including recommendations for their application and use. Include test reports and certifications substantiating that products comply with requirements.
- C. Samples for verification purposes, prior to preparing sample panels, of the following:
 - 1. Each new exposed masonry material to be used for replacing existing materials. Include in each set of samples the full range of colors and textures to be expected in the completed Work.
 - a. Provide straps or panels containing not less than four brick units.

2. Each type of mortar for pointing and masonry rebuilding and repair in the form of sample mortar strips 6 inches long by 1/2 inch wide set in aluminum or plastic channels.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include a list of comparable completed projects with project names, age, condition prior to restoration, addresses and names of Architects and Owners.
- E. Restoration program for each phase of the restoration process, including protection of surrounding materials on building and site during operations. Describe in detail the materials, methods, and equipment to be used for each phase of the restoration work.
- F. Cleaning program indicating cleaning process, including protection of surrounding materials on building and site, and control of runoff during operations. Describe in detail the materials, methods and equipment to be used.

1.5 QUALITY ASSURANCE

- A. Restoration Specialist: Engage an experienced masonry restoration and cleaning firm that has specialized in the types of work required for this Project. The firm shall have been in business for 10 years and shall have worked on five projects of a similar age and scope. At Contractor's option, the work may be divided between two specialist firms: one for cleaning work and one for repair work.
 1. Field Supervision: Require restoration specialist firm to maintain an experienced full-time supervisor on the job site during times that clay masonry restoration and cleaning are in progress.
- B. Field-Constructed Mockups: Prior to starting general masonry restoration, prepare the following sample panels on the building where directed by Architect. Prepare sample panels using same materials and methods proposed for the Work, and under same weather conditions to be expected during the restoration. Obtain Architect's acceptance of visual qualities before proceeding with masonry restoration. Retain acceptable panels in an undisturbed condition, suitably marked, during construction as a standard for judging the completed Work.
 1. Notify Architect one week in advance of dates and times when sample panels will be prepared.
 2. Cleaning: Demonstrate the materials and methods to be used for cleaning each type of masonry surface and condition on sample panels approximately 25 sq. ft. in area.
 - a. Allow a waiting period of the duration indicated, but not less than 7 calendar days, after completion of sample cleaning to permit a study of sample panels for negative reactions.
 3. Repointing: Prepare two separate sample areas approximately 3 feet high by 6 feet wide for each type of repointing required, one for demonstrating methods and quality of workmanship expected in removing mortar from joints and the other for demonstrating quality of materials and workmanship expected in pointing mortar joints.
 4. Masonry Repair: Prepare sample panels of size indicated for each type of masonry material indicated to be patched, rebuilt,

or replaced. Erect sample panels into an existing wall, unless otherwise indicated, to demonstrate the quality of materials and workmanship.

- C. Masonry Pre-construction Testing: Contractor shall employ, at his own expense, an independent testing agency experienced in performing the type of tests indicated and acceptable to Architect to perform the pre-construction tests.
1. Pre-construction brick tests involve testing each type of existing brick indicated for replacement and each type of proposed replacement brick for properties indicated below using the sampling and testing methods in ASTM C 67. Carefully remove existing bricks from locations designated by Architect.
 - a. Compressive strength.
 - b. 24-hour cold water absorption.
 - c. 5-hour boil absorption.
 - d. Saturation coefficient.
 - e. Initial rate of absorption (suction).
 2. Pre-construction mortar tests involve testing each type of existing mortar to help duplicate mortar mix to be reused for repointing compressive strength, color, aggregate, size, mix and materials.
- D. Source of Materials: Obtain materials for masonry restoration from a single source for each type material required (face brick, stone, cement, sand, etc.) to ensure a match of quality, color, pattern, and texture.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Carefully pack, handle, and ship masonry units and accessories strapped together in suitable packs or pallets, or in heavy-duty cartons. Unload and handle to prevent chipping and breakage.
- B. Deliver other materials to Project site in manufacturer's original and unopened containers and packaging, bearing labels as to type and names of products and manufacturers.
- C. Protect masonry restoration materials during storage and construction from rain, snow, and ground water, and from staining and mixing with soil and other materials.
- D. Protect grout, mortar, and other materials from deterioration by moisture and temperature. Store in a dry place or in waterproof containers. Keep containers tightly closed and away from open flames. Protect liquid components from freezing.
- E. Comply with manufacturer's recommendations for minimum and maximum temperature requirements for storage.

1.7 PROJECT CONDITIONS

- A. Clean masonry surfaces only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried out, but for not less than 7 days after completion of cleaning.
- B. Do not repoint mortar joints or repair masonry unless air temperature is between 40 deg F (4 deg C) and 80 deg F (27 deg C) and will remain so for at least 48 hours after completion of work.

- C. Prevent grout or mortar used in repointing and repair work from staining face of surrounding masonry and other surfaces. Immediately remove grout and mortar in contact with exposed masonry and other surfaces.
- D. Protect sills, ledges, and projections from mortar droppings.

1.8 SEQUENCING/SCHEDULING

- A. Order replacement materials at the earliest possible date, to avoid delaying completion of the Work.
- B. Perform masonry restoration work in the following sequence:
 1. Clean masonry surfaces. Remove plants, paint, and soot prior to general cleaning.
 2. Study and note painting styles and methods of producing the maximum both horizontal and vertical joints to determine which were struck first and whether they are the panel style.
 3. Repair existing masonry, including replacing existing masonry with new masonry materials.
 4. Rake out existing mortar from joints indicated to be repointed.
 5. Point existing mortar joints of masonry indicated to be restored.
 6. Clean masonry surfaces. Remove excess mortar from face of brick.

PART 2 - PRODUCTS

2.1 MASONRY MATERIALS

- A. Face Brick and Accessories: Provide face brick and accessories, including units for lintels, arches, corners, and other specially ground, cut, or sawed shapes where required to complete masonry restoration work.
 1. Provide units with color, surface texture, and size to match existing brickwork and with physical properties not less than those determined from pre-construction testing of selected existing units.

2.2 MORTAR MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type II.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Aggregate for Mortar: ASTM C 144, unless otherwise indicated in pre-construction testing.
 1. Colored Mortar Aggregate: Natural or manufactured sand selected to produce mortar color indicated.
 2. For pointing mortar, provide sand with rounded edges.
 3. Match size, texture, and gradation of existing mortar as closely as possible.
- D. Colored Mortar Pigment: Natural and synthetic iron oxides and chromium oxides, compounded for mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars.
- E. Water: Clean, free of oils, acids, alkalis, and organic matter.

2.3 CLEANING MATERIALS AND EQUIPMENT

- A. Water for Cleaning: Clean, potable, free of oils, acids, alkalis, salts, and organic matter.
- B. Warm Water: Heat water to a temperature of 140 to 180 deg F (60 to 82 deg C).
- C. Brushes: Fiber bristle only.
- D. Spray Equipment: Provide equipment for controlled spray application of water at rates indicated for pressure, measured at spray tip, and for volume. Adjust pressure and volume, as required, to ensure that damage to masonry does not result from cleaning methods.
 - 1. For water spray application, provide a fan-shaped spray tip that disperses water at an angle of not less than 15 degrees.
 - 2. For heated water spray application, provide equipment capable of maintaining a temperature at flow rates indicated between 140 and 180 deg F (60 and 82 deg C).
 - 3. For steam application, provide a steam generator capable of delivering live steam at the nozzle head.

2.4 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious and aggregate material in a dry condition by volume or equivalent weight. Do not measure by shovel, use known measure. Mix materials in a clean mechanical paddle batch mixer.
 - 1. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding any water. Then mix again adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for 1 to 2 hours. Add the remaining water in small portions until reaching mortar of the desired consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
- B. Colored Mortar: Produce mortar of color required by using selected ingredients. Do not adjust proportions without Architect's approval.
 - 1. Colored Mortar Pigment: Where colored mortar pigments are indicated. Color may be added to the mix in quantities not to exceed 6% by weight of the content in the mix.
- C. Do not use admixtures of any kind in mortar, unless otherwise indicated.
- D. Mortar Proportions: Submit formula for architects review.
 - 1 part portland cement
 - 1 part hydrated lime
 - 6 part sand

PART 3 - EXECUTION

3.1 CLEANING MASONRY, GENERAL

- A. Clean areas where new construction will attach to the existing masonry. Proceed with cleaning in an orderly manner; work from top to bottom of each scaffold width and from one end of each elevation to

the other. Work from bottom to top of the building for each scaffold drop.

- B. Use only those cleaning methods indicated for each masonry material and location.
- C. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.
- D. Removing Plant Growth: Completely remove plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing to dry as long as possible prior to removal. Remove loose soil and debris from open masonry joints to whatever depth they occur.
- E. Water Application Methods: Where water application methods are indicated, comply with the following:
 - 1. Spray Applications: Spray-apply water to masonry surfaces to comply with requirements indicated for location, purpose, water temperature, pressure, volume, and equipment. Unless otherwise indicated, hold spray nozzle no less than 6 inches from surface of masonry and apply water from side to side in overlapping bands at an angle of not more than 30° from the wall surface to produce uniform coverage and an even effect.
 - a. Low-Pressure Spray: 80 to 275 psi; 3 to 6 gal. per minute.
 - 2. Steam Wash: Apply steam to masonry surfaces at pressures not exceeding 80 psi. Hold nozzle no less than 6 inches from surface of masonry and apply steam from side to side or in the direction of the tooling in overlapping bands at an angle of not more than 30° from the wall surface to produce uniform coverage and an even effect.

3.2 BRICK REMOVAL AND REBUILDING

- A. Carefully remove by hand, at locations indicated, bricks that are damaged, spalled, or deteriorated. Cut out full units from joint to joint and in a manner to permit replacement with full-size units.
- B. Support and protect masonry indicated to remain that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
- C. Salvage as many whole, undamaged bricks as possible.
- D. Remove mortar, loose particles and soil from salvaged brick by cleaning with brushes and water. Store brick for reuse.
- E. Clean remaining brick at edges of removal areas by removing mortar, dust, and loose debris in preparation for rebuilding.

3.3 BRICK REBUILDING

- A. Install new or salvaged brick to replace removed brick. Fit replacement units into bonding and coursing pattern of existing brick. If cutting of new brick is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.

- B. Lay replacement brick with completely filled bed, head, and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet clay bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 grams per 30 sq. in. per minute. Use wetting methods that ensure units are nearly saturated but surface dry when laid. Maintain joint width for replacement units to match existing units.
- C. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
- D. Point new mortar joints in repaired area to comply with requirements for repointing existing masonry, and rake out mortar used for laying brick before mortar sets.

3.6 STONE PATCHING

- A. Cut out deteriorated stone and adjacent stone that have begun to deteriorate. Remove additional stone so that patch will not have feathered edges and will be at least 1/4 inch thick.
- B. Remove loose particles, soil, debris, oil, and other contaminants from existing stone units at locations indicated by cleaning with a stiff-bristle brush.
- C. Brush-coat stone surfaces with mortar-to-stone adhesive complying with manufacturer's directions.
- D. Brush-coat stone surfaces with a slurry coat of patching mortar complying with manufacturer's directions.
- E. Place patching mortar in layers no thicker than 2 inches. Roughen surface of each layer to provide a key for the next.
- F. Building patch up 1/4 inch above surrounding stone and carve surface to match adjoining stone after mortar has hardened.
- G. Keep each layer damp for 72 hours or until mortar has set.
- H. Unacceptable patches are defined as those with hairline cracks or that show separation from stone at edges, and those that do not match adjoining stone in color or texture. Remove patches and refill to provide patches free of those defects.

3.7 REPOINTING MASONRY

- A. Rake out joints as follows:
 - 1. Rake out mortar from joints to depths equal to 2-1/2 times their widths but not less than 1/2 inch nor less than that required to expose sound, unweathered mortar.
 - 2. Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
 - 3. Do not spall edges of masonry units or widen joints. Replace damaged masonry units.
 - a. Cut out old mortar by hand with a chisel and mallet, unless otherwise indicated.

- b. Do not use power-operated rotary handsaws and grinders unless specific Architect's written approval is obtained based on submission by Contractor of a satisfactory quality control program and demonstrated ability of operators to use tools without damaging masonry. Quality control program shall include provisions for supervising performance and preventing damage due to worker fatigue.
- B. Point joints as follows:
1. Rinse masonry joint surfaces with water to remove dust and mortar particles. Time the rinsing application so that at the time of pointing excess water has evaporated or run off and joint surfaces are damp but free of standing water.
 2. Apply the first layer of pointing mortar to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch until a uniform depth is formed. Compact each layer thoroughly and allow it to become thumbprint hard before applying the next layer.
 3. After joints have been filled to a uniform depth, place remaining pointing mortar in three layers with each of first and second layers filling approximately two fifths of joint depth and third layer the remaining one fifth. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing bricks have rounded edges recess final layer slightly from face. Take care not to spread mortar over edges onto exposed masonry surfaces, or to featheredge mortar.
 4. When mortar is thumbprint hard, tool joints to match original appearance of joints, unless otherwise indicated. Remove excess mortar from edge of joint by brushing.
 5. Cure mortar by maintaining in a damp condition for not less than 72 hours.
 6. Where repointing work precedes cleaning of existing masonry, allow mortar to harden not less than 30 days before beginning cleaning work.

3.8 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter using stiff nylon or bristle brushes and clean water, which is spray-applied at a low pressure.
- B. Using metal scrapers or brushes is not permitted.
- C. Using acid or alkali cleaning agents is not permitted.

END OF SECTION 042515

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following metal fabrications:
 - 1. Rough hardware.
 - 2. Loose steel lintels.
 - a. Applications where framing and supports are not specified in other sections.
 - 3. Painting of masonry lintels at windows and doors.
 - 4. Modifications to the existing bar joists and added roof structure to support HVAC equipment.
 - 5. Modifications to support the existing suspended plaster ceiling where it is cut for roof hatch and HVAC equipment.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 4 Section: 045215 Masonry Repairs

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for prefabricated building columns, paint products, and grout.
- C. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
- D. Samples representative of materials and finished products as may be requested by Architect.
- E. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- F. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include a list of completed projects with project name, addresses, names of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this Project with a record of successful in-service performance, and with sufficient production capacity to produce required units without delaying the Work.

- B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel," AWS D1.2 "Structural Welding Code--Aluminum," and AWS D1.3 "Structural Welding Code--Sheet Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: Product type (manufacturing method) and as follows:
 - 1. Cold-Formed Steel Tubing: ASTM A 500.
 - 2. Hot-Formed Steel Tubing: ASTM A 501.
 - a. For exterior installations and where indicated, provide tubing with hot-dip galvanized coating per ASTM A 53.
- D. Steel Pipe: ASTM A 53, standard weight (schedule 40), unless otherwise indicated, or another weight required by structural loads.
 - 1. Black finish, unless otherwise indicated.
 - 2. Galvanized finish for exterior installations and where indicated.
- E. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.
- F. Welding Rods and Bare Electrodes: Select according to AWS specifications for the metal alloy to be welded.

2.2 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems

indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

- B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.
- C. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers.

2.3 FASTENERS

- A. General: Provide plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating, for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568, Property Class 4.6), with hex nuts, ASTM A 563 (ASTM A 563M), and, where indicated, flat washers.
- C. Machine Screws: ANSI B18.6.3.
- D. Lag Bolts: ANSI B18.2.1 (ANSI B18.2.3.8M).
- E. Wood Screws: Flat head, carbon steel, ANSI B18.6.1.
- F. Plain Washers: Round, carbon steel, ANSI B18.22.1 (ANSI B18.22M).
- G. Lock Washers: Helical, spring type, carbon steel, ANSI B18.21.1.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Material: Carbon steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Group 1 alloy 304 or 316 stainless-steel bolts and nuts complying with ASTM F 593 (ASTM F 738M) and ASTM F 594 (ASTM F 836M).
- I. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as required.
- J. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 CONCRETE FILL

- A. Concrete Materials and Properties: Comply with requirements of Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa), unless higher strengths are indicated.

2.5 FABRICATION, GENERAL

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
 - 1. Temperature Change (Range): 100 deg F (55.5 deg C).
- D. Shear and punch metals cleanly and accurately. Remove burrs.
- E. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- F. Remove sharp or rough areas on exposed traffic surfaces.
- G. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- K. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- L. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.6 ROUGH HARDWARE

- A. Furnish bent, or otherwise custom-fabricated, bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 Sections.
- B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts that bear on wood structural connections, and furnish steel washers elsewhere.

2.7 LOOSE STEEL LINTELS

- A. Fabricate loose structural steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Weld adjoining members together to form a single unit where indicated.
- C. Size loose lintels for equal bearing of 1 inch per foot (85 mm per meter) of clear span but not less than 8 inches (200 mm) bearing at each side of openings, unless otherwise indicated.
- D. Shop prime loose steel lintels located in exterior walls.

2.8 STEEL AND IRON FINISHES

- A. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with the following requirements:
 - 1. ASTM A 153 for galvanizing iron and steel hardware.
 - 2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch (0.76 mm) thick or thicker.
- B. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6 "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3 "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages,

including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

- B. Center nosings on tread widths with noses flush with riser faces and tread surfaces.
- C. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal is specified in Division 9 Section "Painting."

END OF SECTION 055000

SECTION 055133 - METAL LADDERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aluminum Ships Ladder for roof hatch access.
- B. Aluminum Roof Ladder between roof areas.

1.2 RELATED SECTIONS

- A. Section 055000 - Structural Steel Framing: Roof structure and opening support.
- B. Section 061000 - Rough Carpentry: Roof framing and opening support.

1.3 SUBMITTALS

- A. Submit under provisions of Section 010000.
- B. Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings for Ladders:
 - 1. Plan and section of ladder installation.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store ladder until installation inside under cover. If stored outside, under a tarp or suitable cover.

1.5 WARRANTY

- A. Limited Warranty: One year against defective material and workmanship, covering parts only, no labor or freight. Defective parts, if deemed so by the manufacturer, will be replaced at no charge, freight excluded, upon inspection at manufacturer's plant which warrants same.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Select from list below or approved equal.
 - 1. Precision Ladders, LLC, which is located at: P. O. Box 2279 ; Morristown, TN 37816-2279; Toll Free Tel: 800-225-7814; Tel: 423-586-2265; Fax: 423-586-2091; Web: www.PrecisionLadders.com
 - 2. O'Keefe's, Inc.; 325 Newhall St. San Francisco, CA 94124. ASD. Toll Free Tel: (888) 653-3333. Tel: (415) 824-4900. Fax: (415) 824-5900. Email: info@okeeffes.com. Web: <http://www.okeeffes.com>.
 - 3. Royalite Manufacturing, Inc; 1055 Terminal Way, San Carlos, CA 94070. ASD. Tel: (650) 637-1440 or (800) 875-9548. Fax: (650) 637-9770. Web: www.royalite-mfg.com
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

2.2 ALUMINUM SHIPS LADDER

- A. Aluminum Ships Ladder and Components: Ladder, mounting brackets and handrails on both sides.
 - 1. Model: Model SL Aluminum Ships Ladder as manufactured by

- Precision Ladders, LLC.
2. Capacity: Unit shall support a 500 lb (227 kg) total load without failure.
 3. Ladder Stringer: 5 inch by 2 inch by 3/16 inch (127 mm by 51 mm by 5 mm) extruded 6005-T5 aluminum channel. Pitch: 60 to 75 degrees.
 4. Ladder Mounting Brackets:
 - a. Floor Bracket: 2 inch by 3 inch by 1/4 inch (51 mm by 76 mm by 6 mm) aluminum angle.
 - b. Top Bracket: 4-3/4 inch by 5 inch by 1/4 inch (121 mm by 127 mm by 6 mm) aluminum angle.
 5. Handrails: 1-1/4 inches (32 mm) Schedule 40, 6005-T5 aluminum pipe provided with internal aluminum fittings.

2.3 FABRICATION

- A. Completely fabricate ladder ready for installation before shipment to the site.
- B. Completely fabricate handrail components ready for field assembly to ladder before shipment to site.

2.4 FINISHES

- A. Mill finish on aluminum components is standard.
- B. Optional finishes are powder coat or clear anodized.

PART 3 EXECUTION

3.1 EXAMINATION

- A. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- B. Examine materials upon arrival at site. Notify the carrier and manufacturer of any damage.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.3 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 055200 - PIPE AND TUBE HANDRAILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe and tube handrails and railing systems.

1.3 DEFINITIONS

- A. Definitions in ASTM E 985 for railing-related terms apply to this Section.

1.4 PERFORMANCE REQUIREMENTS

- A. General: In engineering handrail and railing systems to withstand structural loads indicated, determine allowable design working stresses of materials based on the following:
 - 1. Cold-Formed Structural Steel: AISI "Specification for the Design of Cold-Formed Steel Structural Members."
- B. Structural Performance of Handrails and Railing Systems: Engineer, fabricate, and install handrails and railing systems to comply with requirements of ASTM E 985 for structural performance based on the following:
 - 1. Testing performed according to ASTM E 894 and E 935.
- C. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installing handrails and railing systems to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C) ambient 180 deg F (100 deg C) material surfaces.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for mechanically connected handrails and railing systems, each kind of fitting, grout, anchoring cement, and paint products.
- C. Shop drawings showing fabrication and installation of handrails and railing systems including plans, elevations, sections, details of components, and attachments to other units of Work.
 - 1. Fittings and brackets.

- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include a list of completed projects with project names, addresses, names of architects and owners, and other information specified.
- E. Test reports from an independent testing agency evidencing compliance of handrails and railing systems with ASTM E 985.

1.6 QUALITY ASSURANCE

- A. Single-Source Responsibility: Obtain handrails and railing systems of each type and material from a single manufacturer.
- B. Engineer Qualifications: Professional engineer legally authorized to practice in the jurisdiction where Project is located and experienced in providing engineering services of the kind indicated for handrails and railing systems similar to this Project in material, design, and extent, and that have a record of successful in-service performance.

1.7 STORAGE

- A. Store handrails and railing systems inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Where handrails and railing systems are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating handrails and railing systems without field measurements. Coordinate other construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.9 SEQUENCING AND SCHEDULING

- A. Sequence and coordinate installation of wall handrails as follows:
 - 1. Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering handrails and railing systems that may be incorporated in the Work include, but are not limited to, the local and regional metal craftsman with more than 10 years of documented experience.

2.2 METALS

- A. General: Provide metals free from surface blemishes where exposed to view in the finished unit. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections on finished units are not acceptable.

- B. Steel and Iron: Provide steel and iron in the form indicated, complying with the following requirements:
 - 1. Steel Pipe: ASTM A 53; finish, type, and weight class as follows:
 - a. Black finish at interior locations.
 - b. Galvanized finish for exterior installations.
- C. Brackets, Flanges, and Anchors: Cast or formed metal of the same material and finish as supported rails, unless otherwise indicated.

2.3 WELDING MATERIALS, FASTENERS, AND ANCHORS

- A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of the type, grade, and class required to produce connections that are suitable for anchoring railings to other types of construction indicated and capable of withstanding design loadings.
 - 1. For steel railings and fittings, use plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
- C. Fasteners for Interconnecting Railing Components: Use fasteners of same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
- D. Cast-in-Place and Postinstalled Anchors: Anchors of type indicated below, fabricated from corrosion-resistant materials, capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and equal to 4 times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified, independent testing agency.
 - 1. Expansion anchors.
 - 2. Chemical anchors.

2.4 PAINT

- A. Shop Primers: Provide primers to comply with applicable requirements of Division 9 Section "Painting."

2.5 ANCHORING CEMENT

- A. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without need for protection by a sealer or waterproof coating and is recommended for exterior use by manufacturer.

2.6 FABRICATION

- A. General: Fabricate handrails and railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of hollow members, post spacings, and anchorage, but not less than those required to support structural loads.

- B. Assemble handrails and railing systems in the shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- C. Form changes in direction of members as detailed.
- D. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.
- E. Welded Connections: Fabricate handrails and railing systems for connection of members by welding. For connections made during fabrication, weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At tee and cross intersections, cope ends of intersecting members to fit contour of pipe or tube to which end is joined, and weld all around.
 - 5. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- F. Brackets, Flanges, Fittings, and Anchors: Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing system members to other construction.
- G. Provide inserts and other anchorage devices to connect handrails and railing systems to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railing systems.
- H. For railing posts set in concrete, provide preset sleeves of steel, not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (12 mm) greater than outside dimensions of post, and steel plate forming bottom closure.
- I. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing work.
- J. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.
- K. Provide weepholes, or another means to evacuate entrapped water, in hollow sections of railing members that are exposed to exterior or to moisture from condensation or other sources.
- L. Fabricate joints that will be exposed to weather in a manner to exclude water.
- M. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one half of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and they are assembled or installed to minimize contrast.
- C. Provide exposed fasteners with finish matching appearance, including color and texture, of handrails and railing systems.

2.8 STEEL FINISHES

- A. Galvanized Finish: Hot-dip galvanize items indicated to be galvanized to comply with ASTM A 153 for galvanizing iron and steel hardware.
- B. Fill vent and drain holes that will be exposed in the finished work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. For galvanized handrails and railing systems, provide galvanized fittings, brackets, fasteners, sleeves and other ferrous components.
- D. For nongalvanized steel handrails and railing systems, provide nongalvanized ferrous metal fittings, brackets, fasteners, and sleeves, except provide galvanized anchors where embedded in exterior masonry and concrete construction.
- E. Preparation for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- F. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed railings:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6 "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 7 "Brush Off Blast Cleaning."
- G. Apply shop primer to prepared surfaces of handrails and railing components, unless otherwise indicated. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installing anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors, that are to be embedded in concrete as masonry construction. Coordinate delivery of such items to Project site.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections accurately together to form tight, hairline joints.

- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing handrails and railing systems. Set handrails and railing systems accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.
 - 1. Do not weld, cut, or abrade surfaces of handrails and railing components that have been coated or finished after fabrication and are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (2 mm in 1 m).
 - 3. Set posts plumb within a tolerance of 1/4 inch in 12 feet.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and welded surface matches contours of adjoining surfaces.
- D. Adjust handrails and railing systems prior to anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing handrails and railing systems and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components by welding. Cope or butt components to provide 100 percent contact, or use fittings designed for this purpose.
- B. Expansion Joints: Install expansion joints at locations indicated but not further apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

- A. Anchor posts in concrete with pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, solidly fill annular space between post and sleeve with non-shrink anchoring cement, mixed and placed to comply with anchoring material manufacturer's directions.
- B. Cover anchorage joint with a round steel flange attached to post as follows:
 - 1. Welded to post after placement of anchoring material.

3.5 ATTACHING HANDRAILS TO WALLS

- A. Attach handrails to wall with wall brackets and end fittings. Provide bracket with 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.
- B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

- C. Secure wall brackets and wall return fittings to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.
 - 2. For wood stud partitions, use lag bolts set into wood backing between studs; coordinate with stud installation to accurately locate backing members.

3.6 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.
- B. For galvanized surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

3.7 PROTECTION

- A. Protect finishes of handrails and railing systems from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055200

SECTION 061000 - CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 1. Framing with dimension lumber for furring out for window replacement, door and frame work.
 2. Exterior standing and running trim, rake boards, around the roof and parapets.
 3. Trim out renovated windows and doors with salvaged and replacement trim.
 4. Wood furring, grounds, nailers, and blocking for interior soffits at roof hatch and miscellaneous other areas.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 1. Division 7 Section "Flashing and Sheet Metal" for exterior woodwork specially fabricated for this Project.
 2. Division 9 Section "Painting" for back priming and finishing of finish carpentry.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of factory-fabricated product and process specified, including details of construction relative to materials, dimensions of individual components, profiles, textures, and colors.
- C. Material certificates for dimensional lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use as well as design values approved by the Board of Review of American Lumber Standards Committee.
- D. Wood treatment data as follows including chemical treatment manufacturer's instructions for handling, storing, installation, and finishing of treated material:
 1. For each type of preservative treated wood product include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
 2. Warranty of chemical treatment manufacturer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Arrange for installation of carpentry items by firms that can demonstrate successful experience in installing carpentry items similar in type and quality to those required for this Project.
- B. Source Quality Control: Obtain tolled trim from a single manufacturer to ensure a match of quality, color, pattern and texture.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.
 - 1. For lumber pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.
- B. Do not deliver interior finish carpentry until concrete, plaster, masonry, ceramic tile, and other wet work is complete and cured to a condition of equilibrium and temperature and humidity are maintained at or near occupancy levels.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Obtain and comply with finish carpentry manufacturer's and installer's coordinated advice for optimum temperature and humidity conditions for finish carpentry during its storage and installation.
- B. Weather Conditions: Proceed with finish carpentry only when existing and forecasted weather conditions will permit exterior finish carpentry to be installed in compliance with manufacturer's recommendations and when substrate is completely dry.
- C. Open sealed packages of wood to permit natural adjustment of moisture content and allow wood to acclimate to the room conditions.

1.7 EXTRA MATERIAL

- A. Deliver extra material to owner. Before installation begins, furnish not less than 1.0 percent of the quantity of each type of wood trim profile installed on the project packaged with protective covering for storage and identified with labels clearly describing contents.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

- A. Lumber Standards: Furnish lumber manufactured to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.
- B. Inspection Agencies: Inspection agencies and the abbreviations used to reference them with lumber grades and species include the following:
 - 1. RIS - Redwood Inspection Service.
 - 2. NLGA - National Lumber Grades Authority (Canadian).
 - 3. SPIB - Southern Pine Inspection Bureau.
- C. Grade Stamps: Provide lumber with each piece factory-marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
 - 1. For exposed lumber furnish pieces with grade stamps applied to ends or back of each piece; or omit grade stamps entirely and provide certificates of grade compliance issued by inspection agency.

- D. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.
1. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.

2.2 DIMENSION LUMBER

- A. For light framing (2 to 4 inches thick, 2 to 4 inches wide) provide the following grade and species:
1. "Construction" grade.
 2. Southern Pine graded under SPIB rules.

2.3 EXTERIOR STANDING AND RUNNING TRIM AND RAILS

- A. Trim and Rails: For trim and rails in form of boards and worked products, provide lumber complying with the following requirements including those of the grading agency listed with species.
1. Species: Ponderosa pine or salvaged historic wood to match original.
 - a. Grade: Clear.
 2. Texture: Smooth surfaced.
 3. Lumber for Painted Finish: Solid lumber stock.
 4. Concrete fiber board may be used with approval of architect.

2.4 INTERIOR STANDING AND RUNNING TRIM AND RAILS

- A. Trim and Rails: For trim in form of boards and worked products, provide lumber complying with the following requirements.
1. Species: Poplar or salvaged historic wood to match original.
 2. Select Grade: C Select.
 3. Finish Grade: Prime.
 4. Texture: Smooth surfaced.
 5. Lumber for Painted Finish: Solid lumber stock or glued pieces.
- B. Wood Molding Patterns: To match existing conditions or details as provided.
1. Moldings for Painted Finish: P-Grade.

2.5 CONSTRUCTION PANELS, GENERAL

- A. Construction Panel Standards: Comply with PS 1 "U.S. Product Standard for Construction and Industrial Plywood" for plywood construction panels and, for products not manufactured under PS 1 provisions, with APA PRP-108.
- B. Trademark: Furnish construction panels that are each factory-marked with APA trademark evidencing compliance with grade requirements.

2.6 CONCEALED PERFORMANCE-RATED CONSTRUCTION PANELS

- A. General: Where construction panels are indicated for the following concealed types of applications, provide APA Performance-Rated Panels complying with requirements designated under each application for grade designation, span rating, exposure durability classification, edge detail (where applicable), and thickness.
- B. Combination Subfloor-Underlayment: APA RATED STURD-I-FLOOR.
1. Exposure Durability Classification: EXTERIOR.
 2. Span Rating: As required to suit joist spacing indicated.
 3. Span Rating: 24 oc.
 4. Edge Detail: Tongue and groove.

C. Subflooring: APA RATED SHEATHING.

1. Exposure Durability Classification: EXTERIOR.
2. Span Rating: 24/16.

2.7 FASTENERS

- A. General: Provide fasteners of size and type required for application indicated to provide secure attachment.
1. Provide noncorrosive aluminum fasteners or fasteners with a hot dipped zinc coating per ASTM A 153 or of QISI Type 304 stainless steel.
 2. For finish carpentry, countersink nails and fill surface where face nailing is unavoidable.
- B. Adhesives: Comply with manufacturer's recommendations for adhesives.
- C. Flashing: Comply with requirements of Division 7 Section "Flashing and Sheet Metal" for flashing materials installed in finish carpentry.
- D. Sealants: Comply with requirements of Division 7 Section "Joint Sealants" for materials required for sealing.

2.8 METAL FRAMING ANCHORS

- A. General: Provide metal framing anchors of type, size, metal, and finish to comply with requirements specified including the following:
1. Current Evaluation/Research Reports: Provide products for which model code evaluation/research reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with the building code in effect for this Project.
 2. Allowable Design Loads: Provide products for which manufacturer publishes allowable design loads that are determined from empirical data or by rational engineering analysis and that are demonstrated by comprehensive testing performed by a qualified independent testing laboratory.
- B. Galvanized Steel Sheet: Steel sheet zinc-coated by hot-dip process on continuous lines prior to fabrication to comply with ASTM A 525 for Coating Designation G60 and with ASTM A 446, Grade A (structural quality); ASTM A 526 (commercial quality); or ASTM A 527 (lock-forming quality); as standard with manufacturer for type of anchor indicated.
1. Use galvanized steel framing anchors for rough carpentry.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Discard units of material with defects that impair quality of rough carpentry construction and that are too small to use in fabricating rough carpentry with minimum joints or optimum joint arrangement.
- B. Set rough carpentry to required levels and lines, with members plumb and true to line and cut and fitted.
- C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

- D. Securely attach rough carpentry work to substrate by anchoring and fastening as required to securely attach.
- E. Countersink nail heads on exposed carpentry work and fill holes.
- F. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners

3.2 WOOD FRAMING, GENERAL

- A. Framing Standard: Comply with N.F.P.A. "Manual for Wood Frame Construction," unless otherwise indicated.
- B. Install framing members of nominal 2" x 4"'s at 16" on center or as required to match existing.
- C. Anchor and nail as required to securely attach, and to comply with the following:
 - 1. "Appendix C - Recommended Nailing Schedule" of the BOCA National Building Code.
- D. Do not splice structural members between supports.
- E. Firestop concealed spaces of wood framed walls and partitions at each floor level and at the ceiling line of the top story. Where firestops are not automatically provided by the framing system used, use closely fitted wood blocks of nominal 2-inch-thick lumber of the same width as framing members.

3.3 FINISH CARPENTRY EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting installation and performance of finish carpentry. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.4 FINISH CARPENTRY PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Condition finish carpentry to average prevailing humidity conditions in installation areas before installation for a minimum of 24 hours unless longer conditioning recommended by manufacturer.
- C. Backprime lumber for painted finish exposed on the exterior. Comply with requirements for surface preparation and application in Section "Painting."

3.5 FINISH CARPENTRY INSTALLATION, GENERAL

- A. Do not use finish carpentry materials that are unsound, warped, bowed, twisted, improperly treated or finished, not adequately seasoned, or too small to fabricate with proper jointing arrangements.
 - 1. Do not use manufactured units with defective surfaces, sizes, or patterns.

- B. Install finish carpentry plumb, level, true, and aligned with adjacent materials. Use concealed shims where required for alignment.
 - 1. Scribe and cut finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Install to tolerance of 1/8 inch in 8 feet for plumb and level. Install adjoining finish carpentry with 1/16 inch maximum offset for flush installation and 1/8 inch maximum offset for reveal installation.
 - 3. Coordinate finish carpentry with materials and systems that may be in or adjacent to standing and running trim and rails. Provide cutouts for mechanical and electrical items that penetrate exposed surfaces of trim and rails.
 - C. Finish in accordance with specified requirements.
 - D. Refer to Division 9 Sections for final finishing of finish carpentry.
- 3.6 FINISH CARPENTRY STANDING AND RUNNING TRIM AND RAILS
- A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Stagger joints in adjacent and related standing and running trim and rails. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane back of casings to provide uniform thickness across joints if required.
 - 1. Match grain pattern across joints.
 - 2. Drill pilot holes in hardwood prior to nailing or fastening to prevent splitting. Fasten to prevent movement or warping. Countersink nail heads on exposed carpentry work and fill holes.
 - 3. Fit exterior joints to exclude water. Apply flat grain lumber with bark side exposed to weather.
- 3.7 BOARD SHEATHING AND SUBFLOORING
- A. Install boards with end joints staggered over supports, and with each piece extending over at least 2 spaces between supports. Nail with 8d common nails, spaced 2 per support for board widths of 6 inches and less, 3 per support for widths of 8 inches and more.
 - 1. Apply wall sheathing at 45 degree angle with supports.
- 3.8 ADJUSTING
- A. Repair damaged or defective finish carpentry where possible to eliminate functional or visual defects. Where not possible to repair, replace finish carpentry. Adjust joinery for uniform appearance.
- 3.9 CLEANING
- A. Clean finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.
- 3.10 PROTECTION
- A. Provide final protection and maintain conditions that ensure finish carpentry is without damage or deterioration at time of Substantial Completion.

END OF SECTION 061000

SECTION 075300 - SINGLE-PLY MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Types of roofing systems specified in this Section using single-ply roofing membranes include the following:
 - 1. Totally adhered systems Ethylene Propylene Diene Monomer (EPDM).
 - 2. Existing flashing to be removed, masonry parapets repaired, new flashing installed in the same locations.
 - 3. Existing field of the roof is to be remain, 2" of new insulation mechanically attached, and new roof membrane installed.
- B. Roof insulation related to single-ply membrane roofing is specified in this Section.
- C. Wood nailers, blocking, and other related items are specified in Division 6.
- D. Similar membranes concealed by a wearing surface are excluded by definition and, if required, are specified elsewhere in another Division 7 Section.
- E. Copings and gravel stops are specified in another Division 7 Section.

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- B. Product data, installation instructions, and general recommendations from manufacturer of single-ply membrane system for types of roofing required. Include data substantiating that materials comply with requirements.
- C. Samples of finished roofing sheets, including T-shaped side/end-lap seam. Also include the following:
 - 1. Insulation board.
- D. Shop drawings showing roof configuration, sheet layout, seam locations, colors (as applicable), details at perimeter, and special conditions.
 - 1. Indicate layout of tapered insulation materials.
- E. Pre-roofing conference records.
- F. Test data for pullout resistance of fastening systems.
- G. Certification that materials comply with local VOC limitations.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Obtain primary single-ply membrane roofing from a single manufacturer. Provide secondary materials as recommended by manufacturer of primary materials.

- B. Installer: Engage an experienced Installer that has specialized in installing roofing systems similar to those required for this Project. Installer must be acceptable to or licensed by manufacturer of primary roofing material.
 - 1. Work associated with single-ply membrane roofing, including (but not limited to) insulation, flashing, and membrane sheet joint sealers, is to be performed by Installer of this Work.
- C. Pre-Roofing Conference: Before installing roofing and associated Work, meet at mutually agreed location with Installer, roofing manufacturer, installers of related work, and other entities concerned with roofing performance, including governing authorities, Architect, and Owner. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to participants prior to convening pre-roofing conference.
- D. UL Listing: Provide labeled materials that have been tested and listed by UL in "Building Materials Directory" or by other nationally recognized testing laboratory for Class A rated materials/system.

1.5 PROJECT CONDITIONS

- A. Weather: Proceed with roofing work when existing and forecasted weather conditions permit work to be performed in accordance with manufacturers' recommendations and warranty requirements.
- B. Substrate Conditions: Do not begin roofing installation until substrates have been inspected and are determined to be in satisfactory condition.

1.6 WARRANTY

- A. Special Project Warranty: Submit two executed copies of 2-year "Roofing Warranty" on form included at the end of this Section, covering work of this Section including roofing membrane, composition flashing, roof insulation, and roof accessories, signed and countersigned by Installer (Roofer) and Contractor.
- B. Manufacturer's Warranty: Submit executed copy of single-ply membrane manufacturer's "Limited Service Warranty" agreement including flashing endorsement, signed by an authorized representative of manufacturer. Provide form that was published with product literature as of date of Contract Documents.
- C. Warranty Period: 20 years from date of Substantial Completion.
- D. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Performance: Provide roofing materials identified to be of generic type indicated and tested to show compliance with required performances.
- B. Compatibility: Provide products recommended by manufacturers to be fully compatible with indicated substrates. Provide separation materials as required to eliminate contact between incompatible materials.

2.2 EPDM MEMBRANE

- A. General: Ethylene propylene diene monomers formed into uniform, flexible sheets, complying with ASTM D 4637, Type 1.
 - 1. Class SR: Scrim or fabric internal reinforced.
 - 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: Black.
- B. Fully Adhered EPDM Membrane: Manufacturer's standard installation.
 - 1. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - a. Carlisle Syntec Systems.
 - b. Firestone Building Products Co.
 - c. Approved equal.

2.3 AUXILIARY MATERIALS

- A. Gypsum Board Base: ASTM C 36, Type X, 5/8 inch thick.
- B. Sheet Seaming System: Manufacturer's standard materials for sealing lapped joints, including edge sealer to cover exposed spliced edges as recommended by membrane manufacturer.
- C. Cant Strips, Tapered Edge Strips, and Flashing Accessories: Types recommended by membrane manufacturer, including adhesive tapes, flashing cements, and sealants.
- D. Flashing Material: Manufacturer's standard system compatible with single-ply membrane.
- E. Slip Sheet: Type recommended by membrane manufacturer for protecting membrane from incompatible substrates.
- F. Mechanical Fasteners: Metal or plastic plates, caps, battens, accessory components, and fastening devices to suit substrate and as recommended by membrane manufacturer.
- G. Membrane Adhesive: As recommended by membrane manufacturer for particular substrate and project conditions, formulated to withstand minimum 60-psf uplift force.
 - 1. Provide adhesives that comply with local requirements limiting amounts of volatile organic compounds.
- H. Walk Treads: Manufacturers rubber treads that can be adhered to the membrane roof system.

2.4 INSULATING MATERIALS

- A. General: Provide insulating materials to comply with requirements indicated for materials and with referenced standards in sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.
 - 1. Provide tapered boards where indicated for sloping to drain, scupper and other roof accessory. Fabricate with taper of 1/4 inch per foot, unless otherwise indicated.
- B. Polyisocyanurate Board Roof Insulation: Rigid, cellular, thermal insulation with polyisocyanurate closed-cell foam core and manufacturer's standard facing laminated to both sides; complying with FS HH-I-1972/2, Class 1.

2.5 AUXILIARY INSULATION MATERIALS

- A. Adhesive for Bonding Insulation: Type recommended by insulation manufacturer and complying with fire-resistance requirements.
- B. Mastic Sealer: Type recommended by insulation manufacturer for bonding edge joints and filling voids.
- C. Mechanical Anchors: Corrosion-resistant type as recommended by insulation manufacturer for deck type and complying with fire and insurance wind-uplift rating requirements.
 - 1. Provide system tested and approved for I-60 wind-uplift rating.

PART 3 - EXECUTION

3.1 PREPARING SUBSTRATE

- A. General: Comply with manufacturers' instructions to prepare substrate to receive single-ply membrane system.
 - 1. Verify that penetrations, expansion joints, and blocking are in place and secured and that roof drains are properly clamped into position.
- B. Clean substrate of dust, debris, and other substances detrimental to single-ply system installation. Remove sharp projections.
- C. Install cant strips, flashings, and accessory items as shown and as recommended by manufacturer.
- D. Prime substrate where recommended by manufacturer of materials being installed.
- E. Prevent compounds from entering and clogging drains and conductors and from spilling or migrating onto surfaces of other work.

3.2 INSTALLING INSULATION

- A. General: Extend insulation full thickness in two layers, or in multiple layers over entire surface to be insulated, cutting and fitting tightly around obstructions. Form cant strips, crickets, saddles, and tapered areas with additional material as shown and as required for proper drainage of membrane.
 - 1. Stagger joints in one direction for each course. For multiple layers, stagger joints in both directions between courses with no gaps, to form a complete thermal envelope.
 - 2. Provide tapered units to suit drainage pattern indicated.
 - 3. Tightly fit all insulation to parapet walls, no voids or space allowed. Cut and fit insulation pieces to precisely voids.
- B. Do not install more insulation in a day than can be covered with membrane before end of day or before start of inclement weather.
- C. Secure roof insulation to substrate with mechanical anchors of type and spacing indicated but in no case provide less than one anchor per 4 sq. ft. of surface area or less anchorage than required by FM Loss Prevention Data Sheet 1-28.
- D. Provide protection sheet between insulation and membrane when recommended by membrane manufacturer.

3.3 INSTALLING MEMBRANE

- A. General: Start installation only in presence of manufacturer's technical representative.
 - 1. Cut out and repair membrane defects at the end of each day's work.
- B. Fully Adhered Membrane: Install membrane by unrolling over prepared substrate, lapping adjoining sheets as recommended by manufacturer. Apply adhesive to surfaces to be bonded and roll into place when adhesive has properly cured. Treat seams with special adhesive and apply sealant to exposed sheet edges, tapering application as recommended by manufacturer. Install mechanical fasteners, flashings and counterflashings, and accessories at locations and as recommended by manufacturer.
- C. Walkway Protection: Install walk way units at locations shown and where required for access to roof-mounted equipment. Place treads carefully to avoid damage to membrane, laying over an additional layer of roof membrane material, loosely applied, for additional protection, if required.

3.4 PROTECTING ROOFING

- A. After completing roofing (including associated work), institute appropriate procedures for surveillance and protection of roofing during remainder of construction period. At the end of the construction period, or at a time when remaining construction will in no way affect or endanger roofing, make a final inspection of roofing and prepare a written report to Owner, describing nature and extent of deterioration or damage found.
- B. Repair or replace (as required) deteriorated or defective work found at the time of final inspection to a condition free of damage and deterioration at the time of Substantial Completion and according to the requirements of the specified warranty.

END OF SECTION 075300

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof flashing conditions for roof edges, expansion joints, mechanical equipment, sleeve flashing and other roof details.
 - 2. Counterflashings over flexible base flashings.
 - 3. Cap flashing repairs, copper, over front elevation cornice and door hoods.
- B. Related Sections: The following Sections contain requirements that relate to this section:
 - 1. Section 079000: Joint Sealers.

1.3 REFERENCES

- A. AISI (American Iron and Steel Institute) - Stainless Steel - Uses in Architecture.
- B. ANSI/ASTM B32 - Solder Metal.
- C. ASTM A525 - Steel Sheet, Zinc Coated, (Galvanized) by the Hot-Dip Process.
- D. ASTM D226 - Asphalt-Saturated Organic Felt used in Roofing and Waterproofing.
- E. FS SS-C-153 - Cement, Bituminous, Plastic.
- F. NAAMM - Metal Finishes Handbook.
- G. NRCA (National Roofing Contractors Association) - Roofing Manual.
- H. SMACNA - Sheet Metal and Air Conditioning Contractors National Association.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 01001. Describe material profile, jointing pattern, jointing details, fastening methods, and installation details. The majority of the details are to match existing. Use salvaged sections for profiles.

PART 2 - PRODUCTS

2.1 SHEET MATERIALS

- A. Galvanized Steel: ASTM A-446 grade D, 24 ga., galvanized coating conforming to A-527 G90. Pre-finished color to be selected.
- B. Copper: ASTM B370, cold rolled, 24 oz/sq. ft., 0.032" thick, natural finish.

- C. Metal Drip Edge: Brake-formed sheet metal with at least a 2-inch (50-mm) roof deck flange and a 1-1/2-inch (38-mm) fascia flange with a 3/8-inch (9.6-mm) drip at lower edge. Furnish the following material in lengths of 8 or 10 feet (2.5 to 3 m). Material: 0.7 mm thick galvanized steel.
- D. Metal Step Flashing: At intersection of brick wall and roof or intersection of brick chimney and roof.
 - 1. Material: 0.55 mm thick copper.
- E. Vent Pipe Flashing: Lead conforming to ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick, unless otherwise indicated. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof extending at least 4 inches (100 mm) from pipe onto roof.

2.2 ACCESSORIES

- A. Fastener: For aluminum; aluminum with soft neoprene washers at exposed fasteners. Finish exposed fasteners same as flashing metal. For galvanized steel - gal. steel with neoprene washers.
- B. Underlayment: ASTM D266; No. 30 asphalt saturated roofing felt.
- C. Metal Primer: As required by manufacturer's specifications.
- D. Protective Backing Paint: Bituminous.
- E. Slip Sheet: Rosin sized building paper.
- F. Sealant: Type specified in Section 07900.
- G. Bedding Compound: Rubber-asphalt type as recommended by manufacturer.
- H. Asphalt primer: quick dry primer ASTM D-41.
- I. Solder: ANSI/ASTM B32 type, Grade Sn60 used with rosin flux.
- J. Flux: FS O-F-506.
- K. Reglets: Provide with offset top flange for embedment in masonry mortar joint.
- L. Protective Backing Paint: Zinc chromate alkyd.

2.3 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest practical lengths.
- C. Hem exposed edges on underside 1/2" (13 mm); miter and seam corners.
- D. Fabricate corners from one piece with minimum 18" long legs; solder for rigidity, seal with sealant.
- E. Fabricate vertical faces with bottom edge formed outward 1/4" and hemmed to form drip.
- F. Fabricate flashings to allow toe to extend 6" over roofing. Return and brake edges.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.
- B. Verify membrane termination and base flashings are in place, sealed, and secure.
- C. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Field measure site conditions prior to fabricating work.
- B. Install starter and edge strips, and cleats before starting installation.
- C. Install reglets true to lines and levels. Seal top of reglets with sealant.
- D. Insert flashings into reglets to form tight fit. Secure in place with wedges at maximum 16" on center. Pack remaining spaces with lead wool. Seal flashings into reglets with sealant.
- E. Secure flashings in place using concealed fasteners.
- F. Apply plastic cement compound between metal flashings and flexible flashings.
- G. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- H. Solder metal joints watertight for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.

3.3 INSTALLATION

- A. Conform to drawing details SMACNA and NRCA manuals. New details to be compatible with existing details. Most of the details will match the original.
- B. Flashing: Install metal flashing and trim as indicated and according to details and recommendations of the "Asphalt Roofing" section of "The NRCA Steep Roofing Manual" and ARMA's "Residential Asphalt Roofing Manual."
- C. Sheet Metal Flashing and Trim: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.
 - 1. Expansion Provisions: Provide for thermal expansion of exposed sheet metal work. Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in work cannot be used or would not be sufficiently

- weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
2. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashing. Install counterflashing in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counterflashing joints a minimum of 2 inches (50 mm) and bed with sealant.

3.4 SCHEDULES

- A. Wall Counterflashing, expansion joint cover and parapet cap flashing: prefinished aluminum. Architect to select color.
- B. Sleeve flashing, storm collar, and gutter: prefinished aluminum.
- C. Hoods and cornice trim, reused existing copper, repair in place.

END OF SECTION 076200

SECTION 077233 - ROOF HATCH

PART ONE - GENERAL

1.01 SUMMARY

- A. Work included: Furnishing and installing factory fabricated roof hatch for ships ladder, coordinating with existing conditions.
- B. Related Work: Roof replacement, carpentry for roof curb, roof flashing.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM), 100 Bar Harbor Drive, West Conshocken, PA 19428-2959; (610) 832-9585, fax (610) 832-9555
 - 1. ASTM A 36-93a: Standard Specification for Structural Steel

1.03 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for all materials in this specification.
- B. Shop Drawings: Show profiles, accessories, location, and dimensions.
- C. Samples: Manufacturer to provide upon request; sized to represent material adequately.
- D. Contract Closeout: Roof hatch manufacturer shall provide the manufacturer's Warranty prior to the contract closeout.

1.04 PRODUCT HANDLING

- A. All materials shall be delivered in manufacturer's original packaging.
- B. Store materials in a dry, protected, well-vented area. The contractor shall thoroughly inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.
- C. Remove protective wrapping immediately after installation.

1.05 SUBSTITUTIONS

- A. Proposals for substitution products shall be accepted only from bidding contractors and not less than (10) working days before bid due date. Contractor guarantees that proposed substitution shall meet the performance and quality standards of this specification.

1.06 JOB CONDITIONS

- A. Verify that other trades with related work are complete before installing roof hatch(s).
- B. Mounting surfaces shall be straight and secure; substrates shall be of proper width.
- C. Refer to the construction documents, shop drawings, and manufacturer's installation instructions.
- D. Coordinate installation with roof membrane and roof insulation manufacturer's instructions before starting.
- E. Observe all appropriate OSHA safety guidelines for this work.

1.07 WARRANTY/GUARANTEE

- A. Manufacturer's standard warranty: Materials shall be free of defects in material and workmanship for a period of five years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge. Electrical motors, special finishes, and other special equipment (if applicable) shall be warranted separately by the manufacturers of those products.

PART TWO - PRODUCTS

2.01 MANUFACTURER

- A. BILCO Company, P.O. Box 1203, New Haven, CT 06505,
B. Elmdor, 500 South Azusa, CA 91746,
C. Acudor Products, 80 Little Falls Rd., Fairfield, NJ 07004
D. Or approved equal.

2.02 ROOF HATCH

- A. Furnish and install where indicated on plans metal roof hatch Type E, size width: 4'6" (914mm) x length: 3'0" (914mm). Length denotes hinge side. The roof hatch shall be single leaf and designed to work with ships ladder. The roof hatch shall be pre-assembled from the manufacturer.
- B. Performance characteristics:
1. Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m²) with a maximum deflection of 1/150th of the span or 20 psf (97 kg/m²) wind uplift.
 2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
 3. Operation of the cover shall not be affected by temperature.
 4. Entire hatch shall be weathertight with fully welded corner joints on cover and curb.
- C. Cover: Shall be [select: 14 gauge paint bond G-90 galvanized steel or 11 gauge aluminum] with a 3" (76mm) beaded flange with formed reinforcing members. Cover shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- D. Cover insulation: Shall be fiberglass of 1" (25.4mm) thickness, fully covered and protected by a metal liner [select: 22 gauge paint bond G-90 galvanized steel or 18 gauge aluminum].
- E. Curb: Shall be 12" (305mm) in height and of [select: 14 gauge paint bond G-90 galvanized steel or 11 gauge aluminum]. The curb shall be formed with a 3-1/2" (89mm) flange with 7/16" (11.1mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, that features a flashing system, including stamped tabs, 6" (153mm) on center, to be bent inward to hold single ply roofing membrane securely in place.
- F. Curb insulation: Shall be rigid, high-density fiberboard of 1" (25.4mm) thickness on outside of curb.
- G. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and

controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe for steel construction: through bolted to the curb assembly.

H. Hardware

1. Heavy pintle hinges shall be provided.
2. Cover shall be equipped with a spring latch with interior and exterior turn handles.
3. Roof hatch shall be equipped with interior and exterior padlock hasps.
4. The latch strike shall be a stamped component bolted to the curb assembly.
5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25.4mm) diameter red vinyl grip handle to permit easy release for closing.
6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed.
7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.

- I. Finishes: Factory finish shall be alkyd based red oxide primed steel.

PART THREE - EXECUTION

3.01 INSPECTION

- A. Verify that roof hatch installation will not disrupt other trades. Verify that the substrate is dry, clean, and free of foreign matter. Report and correct defects prior to any installation.

3.02 INSTALLATION

- A. Submit product design drawings for review and approval to the architect before fabrication.
- B. The installer shall check as-built conditions and verify the manufacturer's roof hatch details for accuracy to fit the application prior to fabrication. The installer shall comply with the roof hatch Manufacturer's installation instructions.
- C. The installer shall furnish mechanical fasteners consistent with the roof requirements.

END OF SECTION 077233

SECTION 079000 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes joint sealants for the following locations:
 - 1. Interior joints where doors, windows and trim are repaired and other areas where restoration and repairs require sealants prior to painting.
 - 2. Exterior joints in vertical surfaces horizontal surfaces as indicated below:
 - a. Removing existing sealant from around existing doors, windows and other areas required for demolition. Preparing sealant substrate surfaces for new sealant.
 - b. Sealant and backing at all locations where two different materials joint and where a gap in materials creates a potential water problem or visual crack.
 - c. Sealant and backing required at construction control joints, expansion joints as referenced on plans. All joints between materials of different expansions and contraction rates.
 - d. Sealing around perimeter joints between interior and exterior walls, door and window frames.
 - e. Sealant for head joints on stone coping.
 - f. Sealant at roof flashing.
 - g. Flashing joints and reglets.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 6 Section "Woodwork" for sealing all woodwork and carpentry.
 - 2. Division 9 Section "Painting."

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.
- B. Provide joint sealants for interior applications that have been produced and installed to establish and maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data from manufacturers for each joint sealant product required.
 - 1. Certification by joint sealant manufacturer that sealants plus the primers and cleaners required for sealant installation shall contain no volatile organic compounds.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.
 - B. Conform to Sealant and Waterproofers Institute requirements for materials and installation.
 - C. Product Testing: Provide comprehensive test data for each type of joint sealant based on tests conducted by a qualified independent testing laboratory on current product formulations within a 24-month period preceding date of Contractor's submittal of test results to Architect.
 - 1. Test elastomeric sealants for compliance with requirements specified by reference to ASTM C 920. Include test results for hardness, stain resistance, adhesion and cohesion under cyclic movement (per ASTM C 719), low-temperature flexibility, modulus of elasticity at 100 percent strain, effects of heat aging, and effects of accelerated weathering.
 - D. Field-Constructed Mock-Ups: Prior to installation of joint sealants, apply elastomeric sealants as follows to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution:
 - 1. Joints in field-constructed mock-ups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants specified in this Section.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
 - B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- 1.7 PROJECT CONDITIONS
- A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
 - 2. When joint substrates are wet.
 - B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
 - C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.
- 1.8 SEQUENCING AND SCHEDULING
- A. Sequence installation of joint sealants to occur not less than 21 nor more than 30 days after completion of waterproofing, unless otherwise indicated.

PART 2 - PRODUCTS

JOINT SEALANTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- B. Colors: Provide color of exposed joint sealants to comply with the following:
 - 1. Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.

2.2 ELASTOMERIC JOINT SEALANTS

- A. Exterior sealant, except paving joints, shall be Sonolastic NP-I by Sonneborn, Dymetric by Tremco, Synthacalk GC-5 by Pecora, or approved equal.
- B. Interior sealant shall be Pecora AC-20 acrylic or equal by Sonneborn or Tremco.
- C. Joint fillers and back-up materials, solvents, primers, bond breakers, and cleaners shall be as recommended by sealant manufacturer for various conditions encountered and shall be non-bituminous material.

2.3 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 3. Remove laitance and form release agents from concrete.
 4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealant manufacturer based on pre-construction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - a. Install joint backing to achieve a neck dimension no greater than 1/3 the joint width.
 - b. Do not leave gaps between ends of joint fillers.
 - c. Do not stretch, twist, puncture, or tear joint fillers.
 - d. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.
 2. Install bond breaker tape between sealants where backer rods are not used between sealants and joint fillers or back of joints.
- D. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
- E. Tooling of Non-sag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint.

Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

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

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

END OF SECTION 079000

SECTION 081100 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. Door Schedule see: plans.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Non-rated and fire-rated rolled steel doors, panels and frames.
 - 2. Door Schedule: see plans.
- B. Relates Sections: The following Sections contain requirements that relate to this section
 - 1. Section 045215: Masonry Work & Repairs (mortar fill at metal frames).
 - 2. Section 087100: Finish Hardware.
 - 3. Section 088000: Glazing.
 - 4. Section 099000: Painting (Field painting of doors and frames).

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 01001.
- B. Indicate frame configuration, anchor types and spacings, location of cutouts for hardware, reinforcement, and finish.
- C. Indicate door elevations, internal reinforcement, closure method, and cut outs for glazing.
- D. Submit manufacturer's installation instructions under provisions of Section 01001.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of SDI-100.
- B. Fire rated door, panel and frame construction to conform to ASTM E152, NFPA 252 and UL 10B.
- C. Installed frame and door assembly to conform to NFPA 80 for fire rated class indicated in Schedule and on the Drawings.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable code for fire rated frames and doors.

1.6 DELIVERY, STORAGE AND PROTECTION

- A. Protect products under provisions of Section 010000.
- B. Protect doors and frames with resilient packaging sealed with heat shrunk plastic.
- C. Break seal on-site to permit ventilation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Steelcraft, Inc.
- B. Fenestra
- C. Amweld Building Products, Inc.
- D. CECO
- E. Metal Products Inc.
- F. Substitutions: Under provisions of Section 010000.

2.2 DOORS AND FRAMES

- A. Exterior Doors: SDI-100 Grade II, Model 1.
- B. Interior Doors: SDI-100 Grade I, Model 1.
- C. Interior Frames: 16 gage thick material.

2.3 DOOR CORE

- A. Core: Polystyrene insulation or steel channel grid.
- B. Insulated door insulation value of R-7.

2.4 ACCESSORIES

- A. Rubber Silencers Resilient rubber, 3 on strike side.
- B. Glazing Stops: Rolled steel channel shape, mitered corners; prepared for countersink style tamperproof screws.
- C. Louvers for Mech. Room Doors: extruded aluminum 6063-T5 alloy .050" thick, frames and blades. Fasteners are to be aluminum. All frames are to be mitered at corners and reinforced with corner brackets. Louvers are to be painted.

2.5 PROTECTIVE COATINGS

- A. Bituminous Coating: Fibered asphalt emulsion.
- B. Primer: Zinc chromate type.

2.6 FABRICATION

- A. Fabricate frames as welded unit for drywall slip-on type.
- B. Mullions for Double Doors: Removable type. Provide metal T shaped astragals for double doors.
- C. Fabricate frames and doors with hardware reinforcement plates welded in place. Provide mortar guard boxes.
- D. Reinforce frames wider than 48 inches (1 200 mm) with roll formed steel channels fitted tightly into frame head, flush with top.
- E. Prepare frame for silencers. Provide three single rubber silencers for single doors and mullions of double doors on strike side, and two single silencers on frame head at double doors without mullions.
- F. Attach fire rated label to each frame and door unit.
- G. Close top edge of exterior door flush with inverted steel channel closure. Seal joints watertight.

- H. Fabricate frames for masonry wall coursing with 4 inch head member.
- I. Galvanize all components of the door and frame. Galvanize the top and bottom cap inserts and all stiffeners or reinforcements. Touch up all welded areas, patched or repaired areas.

2.7 FINISH

- A. Interior Units: 0.60 oz/sq ft galvanized.
- B. Primer: Baked on.
- C. Finish: Site applied. See Section 099000 - Painting.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install frames in accordance with SDI-105.
- B. Install doors in accordance with DHI.
- C. Coordinate with masonry and wallboard wall construction for anchor placement.
- D. Coordinate installation of glass and glazing or metal panel in transom and centerlites.
- E. Install roll-formed steel reinforcement channels between two abutting frames. Anchor to structure and floor.

3.2 TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.3 ADJUSTING AND CLEANING

- A. Adjust hardware for smooth and balanced door movement.

3.4 SCHEDULE: See Door Schedule on construction plans.

END OF SECTION 081100

SECTION 085150 - STEEL WINDOWS REPAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes repairs to the existing steel window frames and sashes.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Joint sealing between windows and adjacent materials is specified in Division 7 Section "Joint Sealers."
 - 2. Glazing requirements, including windows specified to be factory glazed, are specified in Division 8 Section "Glazing."
 - 3. Field painting of steel windows is specified in Division 9 Section "Painting."

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Intention is to repair the damaged historic steel frames to working order, including replacing missing hardware. Specialized skills are required for this work.
- B. Crack Tolerances: Once repaired the existing windows are to be as tight as possible intending to match the following tolerances of new windows.
 - 1. Casement Units: It shall not be possible to insert freely a steel feeler gage 2 inches wide by 0.020 inch thick between more than 40 percent of the inside metal to metal contacts between frames and ventilators without forcing.
 - 2. Projected Units: It shall not be possible to insert freely a steel feeler gage 2 inches wide by 0.031 inch thick between the inside metal to metal contacts between frames and ventilators without forcing, or to insert freely a steel feeler gage 2 inches wide by 0.020 inch thick between more than 40 percent of such contacts between frames and ventilators without forcing.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.
 - 1. Shop drawings for each type of window are required. Include information not fully detailed in manufacturer's standard product data and the following:
 - a. Hardware, including latching devices.
 - 2. Samples for Verification Purposes: The Architect reserves the right to require additional samples that show fabrication techniques and workmanship, and design of hardware and accessories.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed installation and repair of steel window units, including historic, similar in design and extent to those required for the project and whose work has resulted in construction with a record of successful in-service performance.

- B. Standards: Comply with applicable recommended specifications of the Steel Window Institute except to the extent more stringent requirements are indicated.
- C. Design Concept: The drawings indicate the size, profiles and dimensional requirements of the steel window types required and are based on the specific types and models indicated and the existing windows. Existing windows are historic and the intent is to match as closely as possible to the existing.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Check actual window openings by accurate field measurement before fabrication. Show recorded measurements on shop drawings.

1.7 SEQUENCING AND SCHEDULING

- A. Scheduling: Complete field painting of window units before installation of glass.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Replacement parts can be secured from any supplier capable of providing the required parts.

2.2 MATERIALS

- A. Steel Window Members: To match existing.
- B. Anchors, Clips and Window Accessories: Provide units of stainless steel, hot-dip zinc coated steel or iron complying with ASTM A 123, or bronze/brass. Provide units with sufficient strength to withstand design pressure indicated.
- C. Compression-Type Glazing Strips and Weatherstripping: Provide compressible stripping for glazing and weatherstripping such as molded EPDM or neoprene gaskets complying with ASTM D 2000, Designation 2BC415 to 3BC620, or molded PVC gaskets complying with ASTM D 2287, or molded expanded EPDM or neoprene gaskets complying with ASTM C 509, Grade 4.
- D. Sealant: For sealants required within fabricated window units, provide type recommended by the manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating. Comply with Division 7 Section "Joint Sealants" of these specifications for selection and installation of sealants.
- E. Glass and Glazing Materials: Refer to the " Glazing" sections of these specifications.

2.3 HARDWARE

- A. Hardware: Provide matching hardware that will work with existing windows, solid bronze hardware, with steel or brass/bronze operating bars and rods. Hardware shall be of sufficient strength to perform the function for which it is intended.
- B. Pivots: Drop-forged steel pivot leaves with brass pins.
- C. Limit Device: Concealed, friction adjustor/stay bar limit device designed to restrict ventilator opening.

2.4 ACCESSORIES

- A. General: Windows are to work with the new wood shutters.

2.5 AWNING WINDOWS

- A. Hardware: Provide the following equipment and operating hardware:
1. Operating Device: Push-bar type operator located on the jamb at the sill.
 2. Lock: Combination lever handle and cam-action lock with concealed pawl.

2.6 REPAIRS

- A. General: Repairs are to return the existing units to be serviceable, hold paint, glazing and seal against the weather.

2.7 FINISHES

- A. General: Existing metal frames and sashes are to be refinished with specific enamel paints for steel windows.
- B. Surface Preparation: Before repairing clean surfaces of dirt, oil, grease, and other contaminants followed by a zinc-phosphate pretreatment.
- C. Prime Coat Finish: After repairs provide high grade rust inhibiting primer designed to bond to existing steel.
- D. Enamel Finish: Immediately after cleaning and pretreatment, apply standard 2-coat enamel finish consisting of prime coat and finish coat.
1. Color and Gloss: to be selected by architect
- E. Protect shop finishes from damage due to shipping, handling, and exposures prior to application of field finish or prior to time of substantial completion where shop finish is the final finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Remove rust for frames and sashes with hand tools, mild cleaner.
- B. Repair window units to plumb, level and true to line, without warp or rack of frames or sashes. Provide proper support and anchor securely to surrounding construction with approved fasteners.
1. Separate zinc-coated steel and other corrodible surfaces from sources of corrosion of electrolytic action at points of contact with other materials, by inserting a bituminous coating or plastic sheet materials.
- C. Set sill members and other members in a bed of compound or with joint fillers or gaskets, as shown, to provide weathertight construction. Refer to the "Joint Sealer" Section of Division 7 for compounds, fillers, and gaskets to be installed concurrently with window units. Coordinate installation with wall flashings and other components of the work.
1. Seal exterior joints between sash, trim and mullions watertight with sealant.
 2. Compounds, joint fillers, and gaskets to be installed after installation of window units are specified as work in another Section in Division 7.

3.2 ADJUSTING

- A. Adjust operating ventilators and hardware to provide a tight fit at contact points and weatherstripping, for smooth operation and a weathertight closure.

3.3 CLEANING

- A. Clean surfaces promptly after installation of windows. Exercise care to avoid damage to the finish. Remove excess glazing and sealant compounds, dirt, and other substances. Lubricate hardware and other moving parts.

3.4 PROTECTION

- A. Initiate and maintain protection and other precautions required through the remainder of the construction period, to ensure that, except for normal weathering, window units will be free of damage or deterioration at the time of Substantial Completion.

END OF SECTION 085150

Section 085213 - Aluminum Clad Wood Windows

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aluminum clad wood double hung, complete with hardware, glazing, weather strip, insect screen, simulated divided lites, specified anchors, trim, and attachments.

1.2 RELATED SECTIONS

- A. Special Requirements 010000 - Submittal Procedures: Shop Drawings, Product Data, and Samples
- B. Special Requirements 010000 - Product Options
- C. Special Requirements 010000 - Product Delivery
- D. Special Requirements 010000 - Storage and Handling Requirements
- E. Special Requirements 010000 - Examination and Preparation
- F. Special Requirements 010000 - Protecting Installed Construction
- G. Section 061000 - Millwork: Wood trim other than furnished by window manufacturer
- H. Section 079200 - Joint Sealants: Sill sealant and perimeter caulking
- I. Section 099000 - Paints and Coatings: Paint or stain other than factory applied finish

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. E 283: Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors.
 - 2. E 330: Standard Test Method for Structural Performance of Exterior Windows, Curtains Walls, and Doors by Uniform Static Air Pressure Difference.
 - 3. E 547: Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential.
 - 4. E 2190: Specification for Sealed Insulated Glass Units.
 - 5. C 1036: Standard Specification for Flat Glass.
- B. WDMA I.S.4: Industry Standard for Water Repellent Preservative Treatment for Millwork.
- C. American Architectural Manufacturers Association / Window and Door Manufacturers Association (AAMA / WDMA): AAMA/WDMA/CSA 101/I.S.2/A440-05. Standard/Specification for Windows, Doors, and Unit Skylights. AAMA/WDMA/CSA 101/I.S.2/A440-08. NAFS - North American Fenestration Standard/Specification for Windows, Doors, and Skylights.
- D. Window and Door Manufacturers Association (WDMA): 101 / I.S.2 WDMA Hallmark Certification Program
- E. Sealed Insulating Glass Manufacturers Association / Insulating Glass Certification Council (SIGMA / IGCC).
- F. American Architectural Manufacturers Association (AAMA): 2605: Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.

- G. National Fenestration Rating Council (NFRC): 101: Procedure for Determining Fenestration Product Thermal Properties.

1.4 SYSTEM DESCRIPTION

- A. Design Pressures are applicable to individual units and may vary with unit size.
- B. Design and Performance Requirements:
1. Window units shall be designed to comply with AAMA/WDMA/CSA 101/I.S.2/A440-05 and AAMA/WDMA/CSA 101/I.S.2/A440-08.NAFS
 - a. Double Hung: LC-PG30-H up to CN 5456
 2. Air leakage shall not exceed the following when tested at LC-30 & LC-40 & CW-40 - 1.57 psf- according to ASTM E 283: LC-30 & LC-40 & CW-40 - 0.30 cfm per square foot of frame.
 3. No water penetration shall occur when units are tested at the following pressure according to ASTM E 547: PG35 - 5.25 psf.
 4. Window assembly shall withstand the following positive or negative uniform static air pressure difference without damage when tested according to ASTM E 330: LC-PG35H40 - 52.5psf.

1.5 SUBMITTALS

- A. Shop Drawings: Submit shop drawings under provisions of Section 010000.
- B. Product Data: Submit catalog data under provisions of Section 010000.
- C. Samples:
1. Submit corner section under provisions of Section 010000.
 2. Include glazing system, quality of construction, and specified finish.
- D. Quality Control Submittals: Submit manufacturer's certifications indicating compliance with specified performance and design requirements under provisions of Section 010000.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: Emergency Egress or Rescue: Comply with requirements for sleeping units of IBC International Building Code.

1.7 DELIVERY

- A. Comply with provisions of LFUCG Special Conditions.
- B. Deliver in original packaging and protect from weather.

1.8 STORAGE AND HANDLING

- A. Prime or seal wood surfaces, including surface to be concealed by wall construction, if more than thirty (30) days will expire between delivery and installation.
- B. Store window units in an upright position in a clean and dry storage area above ground and protect from weather under provisions of Section 010000.

1.9 WARRANTY

- A. Windows shall be warranted to be free from defects in manufacturing, materials, and workmanship for a period of ten (10) years from purchase date.
- B. Insulating glass shall be warranted against visible obstruction through the glass caused by a failure of the insulating glass air seal for a period of twenty (20) years from the date of original purchase.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Hurd Windows
- B. Kolby & Kolby Windows
- C. Sun Windows
- D. Marvin Windows

2.2 FRAME DESCRIPTION

- A. Finger jointed edge-glued pine head and side jambs with clear pine interior veneer;
 - 1. Kiln dried to a moisture content no greater than twelve (12) percent at the time of fabrication.
 - 2. Water repellent preservative treated in accordance with WDMA I.S.4.
- B. Frame thickness: 21/32 inch (17 mm) head jamb, 1-5/16 inch (33 mm) composite side jamb, 21/32 inches (17 mm) sill, 14 degree bevel, 8 degree bevel, 1 5/32 inches (29 mm) flat sill available.
- C. Frame width: to match existing conditions including jamb extensions to fit existing openings. Exterior extruded aluminum clad 0.050 inch (1.3 mm) thick.

2.3 SASH DESCRIPTION

- A. Materials: Clear pine;
 - 1. Kiln dried to a moisture content no greater than twelve (12) percent at the time of fabrication.
 - 2. Water repellent preservative treated in accordance with WDMA I.S.4.
- B. Composite sash thickness: 1-9/16 inches (40 mm) for operating units. Corners slot and tenoned.
- C. Sash exterior extruded aluminum clad 0.045 inch (1.1 mm) thick.
- D. Operable sash tilt to interior for cleaning or removal.

2.4 GLAZING

- A. Select quality complying with ASTM C 1036. Insulating glass SIGMA/IGCC certified to performance level CBA when tested in accordance with ASTM E 774.
- B. Glazing method: Insulating glass (Altitude adjusted).
- C. Glass type: Clear; 11/16" Lo• 180™ with Argon; Lo•²
- D. Glazing seal: Silicone bedding on interior; acrylic foam adhesive tape on exterior.

2.5 FINISH

- A. Exterior: Fluoropolymer modified acrylic topcoat applied over primer. Meets or exceeds AAMA 2605 requirements.
 - 1. Standard Color: manufacturers' standard colors
- B. Interior: Latex prime coat, white.

2.6 HARDWARE

- A. Balance system: Coil spring block and tackle with nylon cord and fiber filled nylon clutch.
- B. Jamb track: Vinyl extrusion. Color: Beige.

- C. Lock: High pressure zinc die-cast cam lock and keeper.
 - 1. Finish: Phosphate coated and electrostatically painted Satin Nickel.

2.7 WEATHER STRIP

- A. Unit is weather stripped at jambs with a foam type material for added long-term performance to seal against both the bottom sash and top sash stiles. The bottom sash has a weather strip to seal against the sill, the top check rail has a weather strip to seal against the bottom check rail, and the top rail seals against a weather strip on the head-jamb parting stop.
- B. Stationary units: Continuous, bulb weather strip at perimeter of sash, concealed slotted bulb weather strip on exterior of sash, pile weather strip on interior of blind stop, dual durometer bulb weather strip at bottom rail. Color: Beige.

2.8 SIMULATED DIVIDED LITES (SDL)

- A. 5/8 inch (16 mm) wide; 7/8 inch (22 mm) wide; 1-1/8 inch (29 mm) wide; with internal spacer bars, spacer bar color to be black.
 - 1. Exterior muntins: 0.055 inch (1.4 mm) thick extruded aluminum.
 - 2. Interior muntins: Pine vertical grain Douglas fir. Muntins adhered to glass with double coated acrylic foam tape.
 - 3. Pattern: Rectangular; Custom lite layout. Finish: Match sash finish.

2.9 ACCESSORIES AND TRIM

- A. Installation Accessories:
 - 1. Package of installation hardware consisting of: Factory installed vinyl sill fin.
 - a. Two 5/16 inch - #10 x 2 1/2 inch jamb jack screws
 - b. Four #7 x 2 inch Phillips pan head installation screws
 - c. Two jamb liner check rail pads
 - d. Two color matched clad jamb plugs (exterior)
 - e. Two wood flat head plugs (interior)
 - 2. Sash lifts: High pressure zinc die-cast. Color: Satin Nickel
- B. Aluminum Extrusions:
 - 1. Profile: Frame expander; Extruded panning; Mullion cover; as indicated on drawings.
 - 2. Finish: Fluoropolymer modified acrylic topcoat applied over primer. Meets or exceeds AAMA 2605 requirements.
 - a. Standard Color: select from manufacturers standard colors.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Before installation, verify openings are plumb, square, and of proper dimension as required in Section 010000. Report frame defects or unsuitable conditions to the General Contractor before proceeding.
- B. Acceptance of Conditions: Beginning of installation confirms acceptance of existing conditions.

3.2 INSTALLATION

- A. Comply with Section 010000.
- B. Assemble and install window unit according to manufacturer's instructions and reviewed shop drawings.

- C. Install sealant and related backing materials at perimeter of unit or assembly in accordance with Section 079200 Joint Sealants. Do not use expansive foam sealant.
- D. Install accessory items as required.

3.3 CLEANING

- A. Remove visible labels and adhesive residue from glass according to manufacturer's instructions.
- B. Leave windows and glass in a clean condition. Final cleaning as required in Section 010000.

3.4 PROTECTING INSTALLED CONSTRUCTION

- A. Comply with Section 010000.
- B. Protect windows from damage by chemicals, solvents, paint, or other construction operations that may cause damage.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Removable panel storm windows for exterior application.

1.2 RELATED SECTIONS

- A. Section 079000 - Joint Sealers.
- B. Section 088000 - Glazing.

1.3 REFERENCES

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 1998.
- B. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels; 1998.

1.4 SUBMITTALS

- A. Submit under provisions of Section 010000.
- B. Product Data: Manufacturer's data sheets for specified products showing compliance with specified requirements; include installation instructions.
- C. Shop Drawings: Show dimensions, layout, profiles and product components; details of anchoring and fastening; sealants and weatherstripping; and recorded field measurements.
- D. Finish Samples: Submit color samples, for approval by Architect, that represent the allowable range of finish established from production material specified.
- E. Component Samples: If requested by Architect, submit samples of anchors, fasteners, hardware, assembled corner sections and other materials and components.
- F. Operation and Maintenance Data: Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance.
- G. Executed warranty documents specified.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
 - 1. Store inside, if possible, in a clean, well-drained area free of dust and corrosive fumes.
 - 2. Stack vertically or on edge so that water cannot accumulate on or within materials. Use non-staining wood or plastic shims between components to provide water drainage and air circulation.

3. Cover materials with tarpaulins or plastic hung on frames to provide air circulation.
4. Keep water away from stored assemblies.

1.6 WARRANTY

- A. **Manufacturer's Warranty:** Submit manufacturer's standard warranty document executed by authorized company official, against defects in materials and workmanship for period of 5 years from the date of Substantial Completion. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. **Acceptable Manufacturer:**
1. Allied Window, Inc., Cincinnati, OH 45241-1861;
 2. Kaufmann by Styline, Monroe, WI
 3. Larson Manufacturing, Brookings, SD
 4. Or approved equal.
- B. Requests for substitutions will be considered in accordance with provisions of Section 010000.

2.2 STORM WINDOWS

- A. **Storm Windows - General:** Provide units that fit existing windows without gaps of more than 1/8 inch (3 mm) in each unit.
1. Verify actual measurements of openings by field measurement before fabrication; show recorded measurements on shop drawings.
 2. Allow for out-of-square and irregular conditions.
 3. Verify frame and sill conditions of each opening before fabrication; provide appropriate fabrication details to suit existing conditions.
- B. **Removable Panel Storm Windows:** Exterior mounted, aluminum framed removable panel(s) in extruded aluminum master frame; panels removable to interior, without hardware on outside;
1. Frame and Sash Sightline: 2-1/8 inch (54 mm) maximum.
 2. Frame Thickness: 3/8 inch (9.5 mm).
 3. Style: Top and bottom removable panels (HOL-C) (top sash of prime windows must be operable to facilitate cleaning).
 4. Removable Panels: Easily removable, held in place with cam-action clips providing positive seal between master frame and panel frame; with full width bottom rail lift handle.
 5. Details to match historic window repair requirements of the National Park Service.

2.3 COMPONENTS

- A. **Master Frame and Panel and Sash Frame Members:** Extruded aluminum with wall thickness not less than 0.062 inches (1.6 mm); miter corners and join with corner keys.
1. Aluminum: 6063-T5 alloy and temper with minimum ultimate strength of 22,000 psi (152 MPa) and yield strength of 16,000 psi (110 MPa).
 2. Corner Keys: Extruded aluminum.
 3. Sill Expander: Where necessary to fit existing sloping sill,

provide H-shaped member below master frame with weep holes.

4. Finish: Clear anodized, complying with AAMA 611, Class 1, AA-M12C22A32 (204-R1).
- B. Fasteners: Zinc plated, cadmium plated or other non-corrosive metal compatible with aluminum.
- C. Type: Tempered float glass, ASTM C1048, quality Q3.
 1. Thickness: 3/16 inch (5 mm).
- D. Glazing Gaskets: Removable and reusable virgin vinyl glazing splines with neatly mitered corners.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that openings are within allowable dimensional tolerances, plumb, level, and clean, provide solid anchoring surface, and are in accordance with approved shop drawings.
- B. Do not install windows until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions, including product data, technical bulletins, catalog installation instructions, and carton instructions.
- B. Install storm windows straight, plumb and level, securely fastened, and without distortion.
- C. Adjust as required for proper operation of operable units.

3.3 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 085290

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Commercial door hardware for the following swinging doors:
 - a. Hollow metal.
 - b. Flush wood.
- B. Related Sections include the following:
 - 1. Division 08 Section "Hollow Metal Doors and Frames" for astragals provided as part of fire-rated labeled assemblies and for door silencers provided as part of hollow-metal frames.
 - 2. Division 08 Section "Flush Wood Doors" for astragals provided as part of fire-rated labeled assemblies.

1.3 SUBMITTALS

- A. Number of Submittals: All items listed in this section are to be included in one submittal prepared by one Supplier.
- B. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Qualification Data:
 - 1. Finish Hardware Installers
 - a. Finish hardware, including electrified hardware, for wood, hollow metal, and aluminum doors to be installed by personnel trained and certified by the manufacturer of the product furnished.
 - b. Provide manufacturer's certificates for installer as part of Contractor's bid information. Failure to supply certificates may result in rejection of bid.
 - 2. Hardware Supplier
 - a. Established contract hardware firm which maintains and operates an office, display, and stock in project area and which is a factory authorized distributor of the lock being furnished.
 - b. Hardware scheduled and furnished by or under direct supervision an Architectural Hardware Consultant.
 - c. All schedules submitted to the Architect for approval and job use must carry the signature and certified seal of this Architectural Hardware Consultant.
 - 3. Architectural Hardware Consultant
 - a. Currently certified by the Door and Hardware Institute.

- b. Full-time employee of the Hardware Supplier or an individual having no contractual ties to any supplier/manufacturer entity.
 - c. Available at reasonable times to Architect, Owner, and Contractor during course of work.
- D. Maintenance Data: For each type of door hardware. Include final hardware schedule, keying schedule, riser diagrams, and point-to-point wiring diagrams in 3-ring binder, labeled on spine with project name and "Door Hardware".
- E. Warranty: Special warranty specified in this Section.
- F. Other Action Submittals:
- 1. Door Hardware Sets: Prepared by or under the supervision of a DHI certified Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule"; other formats will be rejected without review. Double space entries, and number and date each page.
 - b. Numerical Sequence of Sets and Headings: Submittal headings shall be in exact order as hardware sets in specification: one heading only per set. Submittal set numbers shall relate to specification set numbers, ie. if three headings are required for Set 12 due to door width differences, then the heading numbers should be 12.1, 12.2, and 12.3 or employing similar linking logic.
 - c. Door Numbers: Identical to those used in the contract documents.
 - d. Number of Copies: (5).
 - e. Content: Include the following information:
 - 1) Identification number, location, hand, fire rating, and material of each door and frame.
 - 2) Type, style, function, size, quantity, and finish of each door hardware item.
 - 3) Complete designations of every item required for each door or opening including name and manufacturer.
 - 4) Degree of opening for closer and overhead stop and holder installation.
 - 5) Keying information.
 - 6) Fastenings and other pertinent information.
 - 7) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - 8) Explanation of abbreviations, symbols, and codes contained in schedule.
 - 9) Mounting locations for door hardware.
 - 10) Notes included with specification hardware sets transcribed verbatim into submittal hardware sets.
 - 11) Door and frame sizes and materials.
 - 12) List of related door devices specified in other Sections for each door and frame.
 - f. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product

Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.

2. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.4 QUALITY ASSURANCE

- A. Furnish proper hardware types and quantities for door function, hardware mounting and clearances, and to meet applicable codes. Bring discrepancies to the attention of the Architect a minimum of (10) days prior to bid date so that an addendum may be issued. No additional compensation will be allowed after bidding for hardware changes required for proper function, hardware mounting or clearances, or to meet codes.
- B. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- C. Source Limitations: All items listed in hardware sets are to be furnished by one supplier. Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
- D. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Contractor, and Architect, conference participants shall also include Hardware Supplier's Architectural Hardware Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 2. Preliminary key system schematic diagram.
 3. Requirements for key control system.
 4. Address for delivery of keys.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Contractor, and Architect, conference participants shall also include Certified Installer, Hardware Supplier's Architectural Hardware Consultant, and Security Supplier. Review methods and procedures related to electrified door hardware including, but not limited to, the following:
 1. Coordinate electrical roughing-in and other preparatory work to be performed by other trades.
 2. Review sequence of operation for each type of electrified door hardware.
 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review required testing, inspecting, and certifying procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to Owner by registered mail or overnight package service. Obtain Owner's contact name and address from Architect.

1.6 COORDINATION

- A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Distribute templates in a timely manner so as not to delay suppliers. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Five years from date of Substantial Completion, except as follows:
 - a. Manual Closers: 10 years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.
1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:
1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article.
 2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- C. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers specified.

2.2 BUTT HINGES, GENERAL

- A. Quantity: Provide the following, unless otherwise indicated:
1. Two Hinges: For doors with heights up to 60 inches (1524 mm).
 2. Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
 3. Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
 4. For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048 mm).
- B. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- C. Hinge Height, Width, and Weight: Unless otherwise indicated, provide the following:
1. Doors with Exit Devices or 3'6" or more in width: 5" high, heavy-weight hinges.
 2. Doors less than 3'6" in width: 4-1/2" high, standard-weight hinges.
 3. Width: 4-1/2" heavy-weight, 4" standard-weight, unless proper clearance requires a different width.
 4. Doors with Closers: Antifriction-bearing hinges.

5. Retrofit Doors: As required to fit existing preps.
 - D. Hinge Base Metal: Unless otherwise indicated, provide the following:
 1. Exterior and in-swinging restroom door hinges: Stainless steel, with stainless-steel pin.
 2. Balance of hinges: Steel, with steel pin.
 - E. Hinge Options: Provide the following:
 1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for reverse bevel lockable doors.
 2. Corners: Square.
 3. Number of knuckles: Five.
 - F. Fasteners: Comply with the following:
 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 2. Wood Screws: For wood doors and frames.
 3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
 4. Screws: Phillips flat-head. Finish screw heads to match surface of hinges.
 - G. Template Hinge Dimensions: BHMA A156.7.
 - H. Available Manufacturers:
 1. Bommer Industries, Inc. (BI).
 2. Hager Companies (HAG).
 3. McKinney Products Company; an ASSA ABLOY Group company (MCK).
 4. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
 5. PBB, Inc. (PBB)
- 2.3 LOCKS AND LATCHES, GENERAL
- A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
 - B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
 - C. Grade 1 or Grade 2 as indicated by model number in hardware sets.
 - D. Lock Trim:
 1. Levers: Cast.
 - a. Best 14 model with full smooth return.
 2. Lockset Designs: Provide design indicated in hardware sets, or, if sets are provided by another manufacturer, provide designs that match those designated.

- E. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
- F. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
- G. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
 - 1. Strikes for Bored Locks and Latches: BHMA A156.2.

2.4 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
 - 1. Bored Locks: BHMA A156.2.
- B. Bored Locks: BHMA A156.2 Grade 1 or 2 as indicated in hardware sets.
 - 1. Available Manufacturers:
 - a. Best Access Systems; Div. of The Stanley Works (BAS).
 - b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
 - c. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
 - d. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).
 - e. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
 - f. Hager.
 - g. Dorma.

2.5 EXIT DEVICES

- A. Exit Devices: BHMA A156.3, Grade 1.
- B. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
- C. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
- D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

- E. Fasteners. Manufacturer's standard, except furnish sex bolts for attachments to doors.
- F. Shims: Provide shims if needed for clearance.
- G. Available Manufacturers:
 - 1. Detex, Inc. (DTX)
 - 2. Precision Hardware, Inc. (PH).
 - 3. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
 - 4. Yale
 - 5. Corbin-Russwin
 - 6. Hager.
 - 7. Dorma.

2.6 LOCK CYLINDERS

- A. Standard Lock Cylinders: BHMA A156.5, Grade 1.
- B. Cylinders: Provide cylinders for all devices requiring key cylinders to properly function: constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
 - 1. Number of Pins: Seven.
 - 2. Keyway: Manufacturer's standard.
 - 3. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 - 4. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 5. Bored-Lock Type: Cylinders with tailpieces to suit locks.
- C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Small-format Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Construction Keying: Comply with the following:
 - 1. Construction Cores: Provide keyed brass construction cores that are replaceable by permanent cores for locking devices on exterior doors. Provide 5 construction master keys.
 - a. Replace construction cores with permanent cores as directed by Owner.
- E. Supplemental Items: Provide cylinder spacers, collars, and correct cams as needed for proper function of locking devices.
- F. Available Manufacturers:
 - 1. Best Access Systems; Div. of The Stanley Works (BAS).
 - 2. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
 - 3. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
 - 4. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).
 - 5. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
 - 6. Hager.
 - 7. Dorma.

2.7 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:
 - 1. Grand Master Key System: Cylinders are operated by a change key, a master key, a grand master key, and a great-grand master key.
- B. Keys: Nickel silver.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."
 - 2. Quantity: Provide the following:
 - a. Cylinder Change Keys: Three per cylinder.
 - b. Master Keys: Six per master.
 - c. Grand Master Keys: Six.
 - d. Control Keys: Two.
 - e. Construction Control Keys: Two.
 - f. Blanks: Fifty.

2.8 KEY CONTROL SYSTEM

- A. Key Control Cabinet: BHMA A156.5, Grade 1; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.
 - 1. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
 - 2. Locate and mount per direction of Architect.
- B. Cross-Index System: Multiple-index system for recording key information. Include three receipt forms for each key-holding hook.
 - 1. Available Manufacturers:
 - a. Lund Equipment Co., Inc. (LUN).
 - b. MMF Industries (MMF).
 - c. Telkee; a division of Sunroc Corporation (TEL).

2.9 OPERATING TRIM

- A. Materials: Fabricate from stainless steel, unless otherwise indicated.
- B. Dimensions: All dimensions, shapes, fasteners, and other properties identical to models specified in hardware sets.
- C. Available Manufacturers:
 - 1. Hager Companies (HAG).
 - 2. IVES Hardware; an Ingersoll-Rand Company (IVS).
 - 3. McKinney Products Company; an ASSA ABLOY Group company (MCK).

4. Rockwood Manufacturing Company (RM).
5. Trimco (TBM).

2.10 SURFACE CLOSERS

- A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 1. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
- B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.
- C. Fasteners: Manufacturer's standard for arms, shoes and brackets. Sex bolts for fastening closers to doors.
- D. Mounting Accessories: Provide shoes, brackets, drop plates, spacers, etc., as needed for proper mounting of closers and arms to door and frame.
- E. Spring Size of Units: Provide field-sizable closers, adjustable for spring sizes 1-6, plus 50% extra spring power at spring size 6, to meet field conditions and requirements for opening force.
- F. Cylinders: As specified in hardware sets.
- G. Mounting Configuration: Unless otherwise indicated by model number in the hardware sets:
 1. Do not furnish closers capable of being mounted on the corridor side of doors.
 2. Do not furnish regular arm closers in areas accessible to students.
 3. If tri-pack closers are furnished for regular arm applications, remove parallel arm shoe from closer box before delivering to job.
 4. Parallel Arm closers are to be manufacturer's double forged rigid models.
- H. Available Manufacturers:
 1. LCN Closers; an Ingersoll-Rand Company (LCN).
 2. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
 3. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
 4. Norton
 5. Yale
 6. Corbin-Russwin
 7. Hager.
 8. Dorma.

2.11 PROTECTIVE TRIM UNITS

- A. Size:
 - 1. Width
 - a. Singles, and pairs with removable mullions or surface applied astragals: 2 inches (38 mm) less than door width on push side and 1 inch (13 mm) less than door width on pull side
 - b. Other pairs: 1 inch (13 mm) less than door width
 - 2. Height: as specified in door hardware sets; or, if constrained by door bottom rail height, 1" less bottom rail height.
- B. Fasteners: Manufacturer's machine or self-tapping countersunk screws.
- C. Metal Protective Trim Units: BHMA A156.6; beveled 4 sides; fabricated from 0.050-inch- (1.3-mm-) thick stainless steel.
- D. Available Manufacturers:
 - 1. Hager Companies (HAG).
 - 2. IVES Hardware; an Ingersoll-Rand Company (IVS).
 - 3. McKinney Products Company; an ASSA ABLOY Group company (MCK).
 - 4. Rockwood Manufacturing Company (RM).
 - 5. Trimco (TBM).

2.12 MECHANICAL WALL AND FLOOR STOPS AND HOLDERS

- A. Stops and Bumpers: BHMA A156.16, Grade 1.
 - 1. Provide wall stops for doors unless floor, overhead, or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Provide floor stops (and spacers if needed) of proper height and configuration to accommodate floor condition. Where floor or wall stops are not appropriate, provide overhead holders.
 - 2. Properties. Cast construction with fastener suitable for wall or floor condition.
 - 3. Available Manufacturers:
 - a. Hager Companies (HAG).
 - b. IVES Hardware; an Ingersoll-Rand Company (IVS).
 - c. McKinney Products Company; an ASSA ABLOY Group company (MCK).
 - d. Rockwood Manufacturing Company (RM).
 - e. Trimco (TBM).

2.13 OVERHEAD STOPS AND HOLDERS

- A. BHMA A156.8, Grade 1. Template for maximum degree of opening before encountering obstruction.
- B. Available Manufacturers:
 - 1. Architectural Builders Hardware Mfg., Inc. (ABH).
 - 2. Glynn-Johnson; an Ingersoll-Rand Company (GJ).
 - 3. Rixson Specialty Door Controls; an ASSA ABLOY Group company (RIX).
 - 4. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).

2.14 SILENCERS

- A. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame.
- B. Available Manufacturers:
 - 1. Glynn-Johnson; an Ingersoll-Rand Company (GJ).
 - 2. Hager Companies (HAG).
 - 3. IVES Hardware; an Ingersoll-Rand Company (IVS).
 - 4. McKinney Products Company; an ASSA ABLOY Group company (MCK).
 - 5. Rockwood Manufacturing Company (RM).
 - 6. Trimco (TBM).

2.15 DOOR GASKETING

- A. General: Provide continuous weather-strip gasketing on exterior hollow metal doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners as indicated by models in hardware sets.
 - 1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
 - 3. Mullion Gasketing: Fasten to mullions, forming seal when doors are closed.
 - 4. Sweeps: Apply to bottom of in-swinging hollow metal doors, forming seal with threshold when door is closed.
 - 5. Seals integral to threshold at out-swinging exterior hollow metal doors.
- B. Requirements per type of rated door provided (these requirements supersede models indicated in hardware sets):
 - 1. Category A wood doors: provide models indicated in hardware sets.
 - 2. Category B wood doors: provide NGP 9550 (or approved equal) Category G&H seals at jambs and meeting edges. If sound seals are indicated in hardware sets, provide the 9550 seals in addition to the sound seals.
 - 3. Category A and B hollow metal doors: provide models indicated in hardware sets.
- C. Air Leakage: Not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
- D. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.
- E. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 or UBC Standard 7-2.

1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.
- F. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.
- G. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- H. Gasketing Materials:
 1. Adhesive Seals. As specified in hardware sets or approved equal.
 2. Intumescent: As required.
 3. Screwed-on weatherstrip and sweeps. Neoprene.
 4. Panic type thresholds. Neoprene or polyprene.
- I. Available Manufacturers:
 1. Hager Companies (HAG).
 2. National Guard Products (NGP).
 3. Pemko Manufacturing Co. (PEM).
 4. Reese Enterprises (RE).
 5. Door Hardware Systems, Inc. (DHS)

2.16 THRESHOLDS

- A. Standard: BHMA A156.21
- B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
- C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch (13 mm) high.
- D. Fasteners: 1/4"-20 machine screws and expansion anchors.
- E. Gasketing material: At panic-type thresholds: neoprene or polyprene.
- F. Available Manufacturers:
 1. Hager Companies (HAG).
 2. National Guard Products (NGP).
 3. Pemko Manufacturing Co. (PEM).
 4. Reese Enterprises (RE).
 5. Zero International (ZRO).

2.17 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except

in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- C. Fasteners: Manufacturer's standard, except as noted in product sections of this specification.

2.18 FINISHES

- A. Standard: BHMA A156.18, as indicated in door hardware sets.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Mounting Locations:
 - 1. Floor Stops and Holders: Locate at least 20" out from hinge edge of door for maximum degree of opening before door encounters obstruction.
 - 2. Wall Stops: Locate so that lockset spindle and wall stop share horizontal and vertical centerlines.
 - 3. Closers and Overhead Stop/Holders: Template and mount closers and overhead stops for maximum degree of opening before door encounters obstruction. When used with closers, template and locate overhead stops so that closer arm does not fully extend and bottom out.
- C. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- D. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule. Document cross-indexing per manufacturer's instructions.
- E. Weatherstrip and Gasketing: Miter cut at butt joints as needed for neat appearance with no gaps between retainers or bulbs.
- F. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

3.4 FIELD QUALITY CONTROL

- A. Provide Door Hardware Inspection Services and Field Quality Report as indicated below.
- B. Door Hardware Inspection Services
 - 1. Scope
 - a. Inspection of all swinging doors and door hardware immediately following completion of installation.

- b. Inspector to furnish a Field Quality Report, itemized per each individual opening, to the Architect within 7 days of the inspection, including:
 - 1) deficiencies in workmanship and standard industry practices,
 - 2) use of allowable products,
 - 3) use of manufacturer recommended fasteners,
 - 4) compliance with the ADA,
 - 5) proper door/frame/hardware clearances,
 - 6) problems related to function, security, aesthetics or maintenance.
- c. Follow-up inspections as required at additional fee.
- d. Fees to be paid by GC to Inspector within 30 days of invoice.
- 2. Inspector Qualifications
 - 1) Certified Architectural Hardware Consultant.
 - 2) Entirely independent of the supply side of the project, having no familial or financial relationship with any manufacturer, manufacturer's representative, distributor, installer or supplier used on this project.
 - 3) Approved by Architect. Go to <http://www.dhi.org/> for searchable list of local Architectural Hardware Consultants.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
- B. Overhead Stops/holders: Set adjustable stops for maximum degree of opening before door encounters obstruction. Adjust friction to control door.
- C. Door Closers:
 - 1. Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
 - 2. Adjust latch period so that door does not slam nor injure fingers.
 - 3. Adjust spring power so that door properly latches.
 - 4. Adjust backcheck to slow door down before hitting stop point so as to prevent damage to closer, arm, door, frame, and fasteners.
- D. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.

- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DOOR HARDWARE SETS (on following pages followed by Door-Set Index)

Overall Hardware Set Notes:

1. Items listed below in bold indicate screw holes patterns that must be matched in submitted materials.
2. Hardware Sets prefixed with "E" indicate electrical work and materials required.
3. Extensive field measuring by the hardware supplier prior to submittal is required to make sure of hinge sizes, filler plate sizes, lock backsets, strikes, door thicknesses, etc. for the proper sizing, fit and clearances of all materials. No change orders will be granted for these kind of issues.

Hardware Set E01

(1) Panic Device, Rim, 03	2103CD	630	PHI
(1) Keypad Exit Trim	EXZ7EV14KP-PH2-RM	626	BES
(1) Cylinder Core	IE7	626	BES
(1) Mortise Cylinder	1E74	626	BES
(1) Kick Plate	KO050 8 x 2LDW x CS x B4E	630	TRI
(1) Cat H Jamb Seal Set	135NA	628	NGP
(1) Panic Threshold	896N x RCE	628	NGP

Note 1: Re-utilize existing continuous hinge, automatic door operator and actuators. Repair, extend and re-utilize existing electrical service as required for fully functional system.

Hardware Set 01

(1)Mortise Cylinder	1E74	626	BES
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Note 1: Hardware supplier to inspect (prior to submittal) existing lockset on door to submit proper cylinder type and cam.

Hardware Set 01A

(1)Rim Cylinder	IE72	626	BES
(1)Mortise Cylinder	1E74	626	BES
(1)Closer, w/Spring Stop	D-3550 CS	689	RYO

Hardware Set 01B

(1)Rim Cylinder	IE72	626	BES
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Hardware Set 02

(1)Full Surface Continuous Hinge	SL57HD	628	SEL
(1)Storeroom Lock	73KC7D-14D-S3	626	BES
(1)Closer, Parallel Arm	D-1651	689	RYO
(3)Hinge Filler Plates			

Note 1: Balance of existing hardware to remain.

Note 2: Hardware supplier to field inspect prior to submittal for proper size filler plates.

Hardware Set 02A

(1)Storeroom Lock	73KC7D-14D-S3	626	BES
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Note 1: Hardware supplier to field inspect prior to submittal for proper strikes and backset required.

Hardware Set 02B

(3)Butt Hinges	BB5000-404	652	BOM
(1)Storeroom Lock	73KC7D-14D-S3	626	BES
(1)Closer, HD Parallel Arm w/Stop	D-3550 S	689	RYO
(1)Kick Plate	KO050 8 x 2LDW x CS x B4E	630	TRI
(1)Cat H Adhesive Jamb Seal Set	105	DBN	DHS

FINISH HARDWARE

087100 - 17

Note: Hardware supplier to provide deadbolt strike filler plate for frame.

Hardware Set 02C

(1) Full Surface Continuous Hinge	SL57HD	628	SEL
(1) Storeroom Lock	73KC7D-14D-S3	626	BES
(1) Closer, HD Parallel Arm w/Stop	D-3550 S	689	RYO

Hardware Set 02D

(1) Full Surface Continuous Hinge	SL57HD	628	SEL
(1) Storeroom Lock	73KC7D-14D-S3	626	BES
(1) Lock Guard, Cylindrical Lock	1082-6S	630	TRI
(1) Closer, HD Parallel Arm w/Stop	D-3550 S	689	RYO
(1) Cat H Adhesive Jamb Seal Set	105	DBN	DHS

Hardware Set 03

(3) Butt Hinges	BB5000-454	652	BOM
(1) Office Lock	73KC7AB-14D-S3	626	BES
(1) Closer, HD Parallel Arm w/Stop	D-3550 S	689	RYO
(1) Cat H Adhesive Jamb Seal Set	105	DBN	DHS

Note: Balance of existing hardware to remain.

Hardware Set 3A

(1) Office Lock	72KC7AB-14D-S3	626	BES
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Note 1: Hardware supplier to field inspect prior to submittal for proper strikes and backset required.

Hardware Set 3B

(2) Butt Hinges	BB5000-350	652	BOM
(1) Office Lock	72KC7AB-14D-S3	626	BES

Note 1: Hardware supplier to field inspect prior to submittal for proper hinges, strikes and backset required.

Hardware Set 03C

(1) Full Surface Continuous Hinge	SL57HD	628	SEL
(1) Office Lock	73KC7AB-14D-S3	626	BES
(1) Closer, HD Parallel Arm	D-3550 EDA	689	RYO
(1) Floor Stop	1211	626	TRI

Hardware Set 3D

(3) Butt Hinges	BB5000-454	652	BOM
(1) Office Lock	72KC7AB-14D-S3	626	BES
(1) Wall Stop, Convex	1270CX	626	RI

Note 1: Hardware supplier to field inspect prior to submittal for proper strikes and backset required.

Hardware Set 03E

(1) Office Lock	72KC7AB-14D-S3	626	BES
(1) Floor Stop	1211	626	TRI

Note 1: Hardware supplier to field inspect prior to submittal for proper strikes and backset required.

Hardware Set 03F

(1) Office Lock	73KC7AB-14D-S3	626	BES
(1) Closer, HD Parallel Arm w/Stop	D-3550 S	689	RYO

Hardware Set 04

Note 1: No hardware required.

Hardware Set 04A

Note 1: No hardware required.
Note 2: Salvage and box closers for owner's stock.

Hardware Set 05

(3) Hinge Filler Plates

FINISH HARDWARE

087100 - 18

Note 1: Hardware supplier to field inspect prior to submittal for proper size filler plates.

Hardware Set 06			
(3)Butt Hinges	BB5002-454	630	BOM
(1)Panic Device, Rim, 03	2103CD	630	PHI
(1)Rim Cylinder	IE72	626	BES
(1)Mortise Cylinder	1E74	626	BES
(1)AV Pull w/Astragal	1096HA x FC x SP	630	TRI
(1)Closer, HD Parallel Arm	D-3550 EDA	689	RYO
(1)Kick Plate	KO050 8 x 2LDW x CS x B4E	630	TRI
(1)Wall Stop, Convex	1270CX	626	TRI
(1)Cat H Jamb Seal Set	172NA	628	NGP
(1)Sweep	198UA	628	NGP

Note: Clean existing threshold.

Hardware Set 06A			
(1)Full Surface Continuous Hinge	SL57HD	628	SEL
(1)Panic Device, Rim, 03	2103LD x 2103C	630	PHI
(1)Rim Cylinder	IE72	626	BES
(1)AV Pull w/Astragal	1096HA x FC x SP	630	TRI
(1)Closer, HD Parallel Arm	D-3550 EDA	689	RYO
(1)Kick Plate	KO050 8x 2LDWx CSx B4E	630	TRI
(1)Wall Stop, Convex	1270CX	626	TRI
(1)Cat H Jamb Seal Set	172NA	628	NGP
(1)Sweep	198UA	628	NGP
(1)Panic Threshold	896N x RCE	628	NGP
(3)Hinge Filler Plates			

Note 1: Hardware supplier to field inspect prior to submittal for proper size filler plates.

Note 2: Clean existing threshold.

Hardware Set 07			
(1)Rim Cylinder	IE72	626	BES
(1)AV Pull w/Astragal	1096HA x FC x SP	630	TRI
Note: Pull lugs to match Von Duprin 99 through-bolt pattern.			
(1)Closer, w/Spring Stop	4040XP SCUSH	689	LCN
(1)Cat H Jamb Seal Set	172NA	628	NGP
(1)Sweep	198UA	628	NGP

Note 1: Clean existing threshold.

Hardware Set 08			
(1)Office Lock	93K7AB-14C-S3	626	BES
(1)Lock Guard, Cylindrical Lock	1082-6S	630	TRI
(1)Thumb-turn Deadbolt	83T7KSTK	626	BES
(1)Closer Cover for	LCN 4041	689	LCN
(1)Cat H Jamb Seal Set	172NA	628	NGP
(1)Sweep	198UA	628	NGP

Note 1: Hardware supplier to field inspect prior to submittal for proper strikes and backset required.

Note 2: Clean existing threshold.

Hardware Set 08A			
(1)Office Lock	93K7AB-14C-S3	626	BES
Note 1: Hardware supplier to field inspect prior to submittal for proper strikes and backset required.			

Hardware Set 08B			
(1)Office Lock	93K7AB-14C-S3	626	BES
(1)Wall Stop, Convex	1270CX	626	TRI
Note 1: Hardware supplier to field inspect prior to submittal for proper strikes and backset required.			

Hardware Set 09

FINISH HARDWARE

087100 - 19

(1)Closer Cover for LCN 4041 689 LCN
(1)Kick Plate KO050 8 x 2LDW x CS x B4E 630 TRI
Note 1: Hardware supplier to field inspect prior to submittal for proper size kickplate.
Note 2: Clean existing threshold.

Hardware Set 10

(1)Mortise Cylinder 1E74 626 BES
(1)4041 Closer Body 689 LCN
Note 1: Hardware supplier to inspect (prior to submittal) existing mortise lockset on door to submit proper cylinder cam.
Note 2: Clean existing threshold.

Hardware Set 11

(2)Continuous Hinge SL24HD 628 SEL
(2)Panic Device, SVR, 01 5201LD 689 PHI
(2)Closer, w/Spring Stop D-3550 CS 689 RYO
(2)Kick Plate KO050 8 x 2LDW x CS x B4E 630 TRI
(1)Cat H Jamb Seal Set 172NA 628 NGP
(1)Cat H Adhesive Astragal SA DBN DHS
(1)Panic Threshold 896N x RCE 628 NGP

Hardware Set 12

(2)Full Surface Continuous Hinge SL57HD 628 SEL
(2)Push/Pull Bar Set 1737 x L x J-R4 Mtg 630 TRI
(2)Closer, w/Spring Stop D-3550 CS 689 RYO
(1)Cat H Jamb Seal Set 172NA 628 NGP
(1)Cat H Adhesive Astragal SA DBN DHS

Hardware Set 13

(1)Full Surface Continuous Hinge SL57HD 628 SEL
(1)Closer, HD Parallel Arm D-4550 EDA 689 RYO
(1)Wall Stop, Convex 1270CX 626 TRI

Hardware Set 14

(1)Classroom Lock 73KC7R-14D-S3 626 BES
Note 1: Adjust closer arm at Door 140. Fill holes in frame at Door 211.

Hardware Set 14A

(3)Butt Hinges BB5000-454 652 BOM
(1)Classroom Lock 73KC7R-14D-S3 626 BES
(1)Closer, HD Parallel Arm w/Stop D-3550 S 689 RYO
(1)Cat H Adhesive Jamb Seal Set 105 DBN DHS
Note: Hardware supplier to provide wrap-around plate to cover existing deadbolt prep and strike filler plate for frame.

Hardware Set 14B

(1)Full Surface Continuous Hinge SL57HD 628 SEL
(1)Classroom Lock 73KC7R-14D-S3 626 BES
(1)Closer, HD Parallel Arm D-3550 EDA 689 RYO
(1)Kick Plate KO050 8 x 2LDW x CS x B4E 630 TRI
(1)Wall Stop/Holder 1283-6S 626 TRI

Hardware Set 14C

(1)Classroom Lock 73KC7R-14D-S3 626 BES
(1)Floor Stop 1211 626 TRI

Hardware Set 14D

(1)Classroom Lock 73KC7R-14D-S3 626 BES
(1)Kick Plate KO050 8 x 2LDW x CS x B4E 630 TRI

Hardware Set 15

(1)Full Surface Continuous Hinge SL57HD 628 SEL
(1)Push Plate 1809-4 630 TRI

FINISH HARDWARE

(1) Pull Plate	1014-3B	630	TRI
(1) Closer, w/Spring Stop	D-3550 CS	689	RYO
(1) Kick Plate	KO050 8 x 2LDW x CS x B4E	630	TRI

Note: Relocate Door 127 from opening 133.

Hardware Set 15A			
(1) Full Surface Continuous Hinge	SL57HD	628	SEL
(1) Push Plate	1809-4	630	TRI
(1) Pull Plate	1014-3B	630	TRI
(1) Kick Plate	KO050 8 x 2LDW x CS x B4E	630	TRI

Note: Reuse closers from existing doors.

Hardware Set 16			
(3) Butt Hinges	BB5000-404	652	BOM
(1) Passage Set	45H70N-14J	626	BES
(1) Thumb-turn Deadbolt	83T7KSTK	626	BES

Hardware Set 17			
(3) Butt Hinges	BB5000-404	652	BOM
(1) Office Lock	45H7A-14J	626	BES
(1) Thumb-turn Deadbolt	83T7KSTK	626	BES

Hardware Set 18			
(1) Panic Device, Rim, 01	5101LD	689	PHI

Hardware Set 18A			
(3) Butt Hinges	BB5002-454	630	BOM
(1) Panic Device, Rim, 03	5103CDx 703A	689	PHI
(1) Rim Cylinder	IE72	626	BES
(1) Mortise Cylinder	1E74	626	BES
(1) Closer, w/Spring Stop	D-3550 CS	689	RYO
(1) Kick Plate	KO050 8x 2LDWx CSx B4E	630	TRI

Note: Hardware supplier to provide strike filler plate.

3.8 DOOR-SET INDEX (on follow page)

Door	Set
01	01
02	02
03	03
04	04
05	05
101	E01
102	06
103	06A
104	07
105	08
106	09
107	10
108	11
109	12
110	13
111	08A
112	03A
113	03B
114	08B
115	04
116	02A
117	01A
118	14
119	04
120	03C
121	03D
122	03A
123	01
124	04A
125	14A
126	02B
127	15
128	01
129	16

130	03E
131	03E
132	03E
133	04
134	02C
135	03E
136	03A
137	17
138	14B
139	04
140	14
141	02D
142	14C
143	15
144	13
145	04
201	18
202	01
203	04
204	14d
205	03F
206	03A
207	03A
208	03A
209	04
210	14
211	14
212	18A
213	15
214	01B
215	01B
216	15
217	02B
218	03A

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes glazing for the following products, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 1. Window units.
 2. Vision lites in doors.

1.3 DEFINITIONS

- A. Manufacturer is used in this Section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.
- B. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's directions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- C. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's directions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated glass standard.
- D. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use due to causes other than glass breakage and improper practices for maintaining, and cleaning insulating glass. Evidence of failure is the obstruction of vision by dust, moisture, or film on the interior surfaces of glass. Improper practices for maintaining and cleaning glass do not comply with the manufacturer's directions.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; and other defects in construction.
- B. Glass Design: Glass thicknesses indicated on Drawings are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for the various size openings in the thicknesses and strengths (annealed or heat-treated) to meet or exceed the following criteria:
 1. Minimum glass thickness, nominally, of lites in exterior walls is 6.0 mm (0.23 inch).
 2. Tinted and heat-absorbing glass thicknesses for each tint indicated are the same throughout Project.

3. Minimum glass thicknesses of lites, whether composed of annealed or heat-treated glass, are selected so the worst-case probability of failure does not exceed the following:
 - a. 8 lites per 1000 for lites set vertically or not over 15 degrees off vertical and under wind action. Determine minimum thickness of monolithic annealed glass according to ASTM E 1300. For other than monolithic annealed glass, determine thickness per glass manufacturer's standard method of analysis including applying adjustment factors to ASTM E 1300 based on type of glass.
 - b. 1 lite per 1000 for lites set over 15 degrees off vertical and under action of wind or snow.
- C. Normal thermal movement results from the following maximum change (range) in ambient and surface temperatures acting on glass-framing members and glazing components. Base engineering calculation on materials' actual surface temperatures due to both solar heat gain and nighttime sky heat loss.
 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.5 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each glass product and glazing material indicated.
- C. Samples for verification purposes of 12-inch-square samples of each type of glass indicated except for clear monolithic glass products, and 12-inch-long samples of each color required (except black) for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative in color of the adjoining framing system.
- D. Product certificates signed by glazing materials manufacturers certifying that their products comply with specified requirements.
 1. Separate certifications are not required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program of a recognized certification agency or independent testing agency acceptable to authorities having jurisdiction.
- E. Compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed for adhesion.
- F. Compatibility test report from manufacturer of insulating glass edge sealant indicating that glass edge sealants were tested for compatibility with other glazing materials including sealants, glazing tape, gaskets, setting blocks, and edge blocks.
- G. Product test reports for each type of glazing sealant and gasket indicated, evidencing compliance with requirements specified.
- H. Maintenance data for glass and other glazing materials to include in Operating and Maintenance Manual specified in Division 1.

1.6 QUALITY ASSURANCE

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for

glazing terms not otherwise defined in this Section or in referenced standards.

1. FGMA Publications: "FGMA Glazing Manual."
 2. AAMA Publications: AAMA TIR-A7 "Sloped Glazing Guidelines" and "Glass Design for Sloped Glazing."
 3. LSGA Publications: "LSGA Design Guide."
 4. SIGMA Publications: TM-3000 "Vertical Glazing Guidelines" and TB-3001 "Sloped Glazing Guidelines."
- B. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.
1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.
- C. Fire-Resistive Glazing Products for Door Assemblies: Products identical to those tested per ASTM E 152, labeled and listed by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
- D. Fire-Resistive Glazing Products for Window Assemblies: Products identical to those tested per ASTM E 163, labeled and listed by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
- E. Insulating Glass Certification Program: Provide insulating glass units permanently marked either on spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency indicated below:
1. Insulating Glass Certification Council (IGCC).
 2. Associated Laboratories, Inc. (ALI).
 3. National Certified Testing Laboratories (NCTL).
- F. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in-service performance.
- G. Single-Source Responsibility for Glass: Obtain glass from one source for each product indicated below:
1. Primary glass of each (ASTM C 1036) type and class indicated.
 2. Laminated glass of each (ASTM C 1172) kind indicated.
- H. Single-Source Responsibility for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.
- I. Field-Constructed Mockups: Prior to glazing, erect mockups for each glass product indicated below to verify selections made under sample submittals and to demonstrate aesthetic effects and quality of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final unit of Work:
1. Glass Products: Erect mockups with the following kinds of glass to match glazing systems required for Project, including typical lite size, framing systems, and glazing methods:
 - a. Fully tempered glass.
 - b. Laminated glass.
 2. Place mockups on site in location and of size indicated or, if not indicated, as directed by Architect.
 3. Notify Architect one week in advance of the dates and times when mockups will be erected.
 4. Obtain Architect's acceptance of mockups before start of final unit of Work.
 5. Demonstrate the proposed range of aesthetic effects and workmanship.

6. Retain and maintain mockups during construction in undisturbed condition as a standard for judging completed unit of Work.
 - a. When directed, demolish and remove mockups from Project site.
 - b. Accepted mockups in undisturbed condition at time of Substantial Completion may become part of completed unit of Work.

 - J. Preconstruction Compatibility and Adhesion Testing: Submit to sealant manufacturers, samples of each glass, gasket, glazing accessory, and glass-framing member that will contact or affect glazing sealants for compatibility and adhesion testing as indicated below:
 1. Use test methods standard with sealant manufacturer to determine if priming and other specific preparation techniques are required for rapid, optimum glazing sealants adhesion to glass and glazing channel substrates.
 - a. Perform tests under normal environmental conditions during installation.
 2. Submit not less than nine pieces of each type and finish of glass-framing members and each type, class, kind, condition, and form of glass (monolithic, laminated, insulating units) for adhesion testing, as well as one sample of each glazing accessory (gaskets, setting blocks and spacers) for compatibility testing.
 3. Schedule sufficient time to test and analyze results to prevent delay in the Work.
 4. Investigate materials failing compatibility or adhesion tests and get sealant manufacturer's written recommendations for corrective measures, including using special primers.
 5. Testing is not required when glazing sealant manufacturer can submit required preparation data that is acceptable to Architect and is based on previous testing of current sealant products for adhesion to and compatibility with submitted glazing materials.

 - K. Pre-Installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Protect glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
 1. Where insulating glass units will be exposed to substantial altitude changes, comply with insulating glass fabricator's recommendations for venting and sealing to avoid hermetic seal ruptures.
- 1.8 PROJECT CONDITIONS
- A. Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing materials manufacturer or when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 1. Install liquid sealants at ambient and substrate temperatures above 40 deg F (4.4 deg C).
- 1.9 WARRANTY
- A. General: Warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

 - B. Manufacturer's Warranty on Coated Glass Products: Submit written warranty signed by coated glass manufacturer agreeing to furnish replacements for those coated glass units that deteriorate as defined in "Definitions" article, f.o.b. point of manufacture, freight allowed

Project site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to glass manufacturer's published instructions.

1. Warranty Period: Manufacturer's standard but not less than 5 years after date of Substantial Completion.
- C. Manufacturer's Warranty on Laminated Glass: Submit written warranty signed by insulating glass manufacturer agreeing to furnish replacements for those laminated glass units that deteriorate as defined in the "Definitions" article, f.o.b. point of manufacture, freight allowed Project site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to glass manufacturer's published instructions.
1. Warranty Period: Manufacturer's standard but not less than 5 years after date of Substantial Completion.
- D. Manufacturer's Warranty on Insulating Glass: Submit written warranty signed by manufacturer of insulating glass agreeing to furnish replacements for insulating glass units that deteriorate as defined in "Definitions" article, f.o.b. point of manufacture, freight allowed Project site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, protecting, and maintaining practices contrary to glass manufacturer's published instructions.
1. Warranty Period: Manufacturer's standard but not less than 10 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the products specified in Product Data Sheets at end of this Section.
- B. Products: Subject to compliance with requirements, provide one of the products specified in Product Data Sheets at end of this Section.

2.2 PRIMARY FLOAT GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I (transparent glass, flat), Class as indicated below, and Quality q3 (glazing select).
 1. Class 1 (clear) unless otherwise indicated.
- B. Refer to Primary Clear Float Glass Product Data Sheet for Class 1 uncoated tinted glass for monolithic glazing.

2.3 LAMINATED GLASS PRODUCTS

- A. Laminated Glass Products: Comply with ASTM C 1172 for kinds of laminated glass indicated and other requirements specified, including those in Laminated Glass Product Data Sheet at the end of this Section. Refer to primary and heat-treated glass requirements relating to properties of glass products comprising laminated glass products.
- B. Interlayer: Interlayer material as indicated below, in clear or colors, and of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
 1. Interlayer Material: Polyvinyl butyral sheets.
 2. Interlayer Material: Urethane acrylate resin.
 3. Interlayer Material: Polyvinyl butyral sheets or urethane acrylate resin.

4. Available Products: Subject to compliance with requirements, the plastic interlayer products that may be incorporated in the Work include, but are not limited to, the following:
5. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyvinyl Butyral Interlayer:
 - 1) Saflex, Monsanto Co.
 - 2) Butacite, E. I. du Pont de Nemours & Co., Inc.
 - b. Urethane Acrylate Resin:
 - 1) Uvekol, UCB Chemicals Corp.
- C. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets as follows:
 1. Laminate lites with polyvinyl butyral interlayer in autoclave with heat plus pressure.
 2. Laminate lites with urethane acrylate resin by exposing assembled units to ultraviolet light after pumping interlayer material into space between lites.

2.4 ELASTOMERIC GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
 1. Compatibility: Select glazing sealants and tapes of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturer's recommendations for selecting glazing sealants and tapes that are suitable for applications indicated and conditions existing at time of installation.
 3. Colors: Provide color of exposed joint sealants to comply with the following:
 - a. Match colors indicated by reference to manufacturer's standard designations.
 - b. Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.
- B. Elastomeric Glazing Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that comply with ASTM C 920 requirements indicated on each Elastomeric Glazing Sealant Product Data Sheet at the end of this Section, including those referencing ASTM classifications for Type, Grade, Class and Uses.
 1. Additional Movement Capability: Where additional movement capability is specified in Elastomeric Glazing Sealant Product Data Sheet, provide products, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, with the capability to withstand the specified percentage change in the joint width existing at time of installation and remain in compliance with other requirements of ASTM C 920 for uses indicated.
- C. Glazing Sealant for Fire-Resistant Glazing Products: Identical to product used in test assembly to obtain fire-resistive rating.

2.5 GLAZING GASKETS

- A. Soft Compression Gaskets: Extruded or molded closed-cell, integral-skinned gaskets of material indicated below, complying with ASTM C 509, Type II, black, and of profile and hardness required to maintain watertight seal:
 1. Neoprene.
 2. EPDM.
 3. Silicone.
 4. Thermoplastic polyolefin rubber.
 5. Any material indicated above.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following companies.
 - 1. Preformed Gaskets:
 - a. Advanced Elastomer Systems, L.P.
 - b. Schnee-Morehead, Inc.
 - c. Tremco, Inc.

2.6 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials involved for glazing application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85 plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side-walking).
- F. Plastic Foam Joint Fillers: Preformed, compressible, resilient, nonstaining, nonextruding, nonoutgassing, strips of closed-cell plastic foam of density, size, and shape to control sealant depth and otherwise contribute to produce optimum sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistive rating.

2.7 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard as required to comply with system performance requirements.
- B. Clean cut or flat grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine glass framing, with glazier present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.
 - 2. Presence and functioning of weep system.
 - 3. Minimum required face or edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.

3.3 GLAZING, GENERAL

- A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.
- B. Glazing channel dimensions as indicated on Drawings provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- C. Protect glass from edge damage during handling and installation as follows:
 - 1. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.
 - 2. Remove damaged glass from Project site and legally dispose of off site. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
- E. Install elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass sizes larger than 50 united inches (length plus height) as follows:
 - 1. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 SEALANT GLAZING (WET)

- A. Install continuous spacers between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass. Install pressurized gaskets to protrude slightly out of channel to eliminate dirt and moisture pockets.

3.5 PROTECTION AND CLEANING

- A. Protect exterior glass from breakage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkali deposits, or stains, and remove as recommended by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents and vandalism, during construction period.
- E. Wash glass on both faces in each area of Project not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

END OF SECTION 088000

SECTION 099000 PAINTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This section includes the following:
 1. Surface preparation, all preparation required to make all painted surfaces ready to paint, including sealants and sanding of surfaces.
 2. New work to be painted, repaired interior doors and frames, replacement and restored windows, exterior doors and frames, exposed cutting and patching for HVAC, electrical, and work associated with the limited rehabilitation project.
 3. Surface finish schedule for painted items.
- B. Related Work under this section to include:
 - 1.) Painting of ferrous metal, including metal doors and frames.
 - 2.) Painting of galvanized metal including new and repaired exterior handrails, guardrails, stairs and balusters.
 - 3.) Painting of wood items, interior misc. millwork and trim associated with door and window renovation.
 - 4.) Painting of patched and repaired interior plaster surfaces associated .
 - 5.) Painting of all drywall wall and ceiling surfaces.
 - 6.) Painting of all exposed steel structural members, including mechanical equipment supports and exterior metal.
 - 7.) Painting of mechanical and electrical work, all pipes to be painted where exposed in mechanical spaces.
 - 8.) Painting of existing and new windows at interior and exterior.
 - 9.) It is the responsibility of this subcontractor to verify with the other spec sections the items to be painted.

1.03 REGULATORY REQUIREMENTS

- A. Conform to the Kentucky Building Code for flame/fuel/smoke rating requirements for finishes.

1.04 SUBMITTALS

- A. Submit product data under provisions of Section 010000, Submissions.
- B. Provide product data on all finishing products and special coating.
- C. Submit manufacturer's application instructions under provisions of Section 010000.

1.05 DEFINITIONS

- A. Conform to ANSI/ASTM D16 for interpretation of terms used in this Section.

1.06 QUALITY ASSURANCE

- A. Product Manufacturer: Company specializing in manufacturing quality paint and finish products with 5 years experience.
- B. Applicator: Company specializing in commercial painting and finishing with 5 years documented experience.

1.07 FIELD SAMPLES

- A. Provide samples under provisions of Section 010000.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 010000.
- B. Store and protect products under provisions of Section 010000.
- C. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.
- D. Container labeling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.
- E. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in well ventilated area, unless required otherwise by manufacturer's instructions.
- F. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45 degrees F for 24 hours before, during, and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is above 50 percent, unless required otherwise by manufacturer's instructions.
- C. Minimum Application Temperatures for Latex Paints: 45 degrees F (7 degrees C) for interiors; 50 degrees F (10 degrees C) for exterior; unless required otherwise by manufacturer's instructions.
- D. Minimum Application Temperature for Varnish and Epoxy Finishes: 65 degrees F (18 degrees C) for interior or exterior, unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.10 EXTRA STOCK

- A. Provide a one gallon container of each color and surface texture to Owner.
- B. Label each container with color, texture, room locations, and indicate if wall or trim paint in addition to the manufacturer's label.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - PAINT

- A. Benjamin Moore Product: exterior and interior alkyd enamels and all latex enamels
- B. Sherwin Williams Paints Product: same

- C. Farrell-Calhoun Product: same
- D. Porter Paint: same
- E. Substitutions: Under provisions of General Conditions.

2.02 ACCEPTABLE MANUFACTURERS - PRIMER-SEALERS

- A. Benjamin Moore Product: Moorcraft Latex Primer-Sealer
- B. Sherwin Williams
- C. Farrell-Calhoun
- D. Porter Paint
- E. Substitutions: Under provisions of Section 010000.

2.03 ACCEPTABLE MANUFACTURERS - BLOCK FILLER

- A. Benjamin Moore Product: Moorcraft Block Filler
- B. Sherwin Williams
- C. Farrell-Calhoun
- D. Porter Paint
- E. Substitutions: Under provisions of General Conditions.

2.04 MATERIALS

- A. Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.
- B. Coatings: Good flow and brushing properties; capable of drying or curing free of streaks or sags.
- C. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.
- D. All surfaces shall be painted with materials from the same manufacturer from primer through finish coat.

2.05 FINISHES

- A. Refer to Room Finish Schedule, Door Schedule and Window Schedule for finish types and locations. Color Schedule will be submitted by Architect prior to prime coating.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Plaster and Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete, and Concrete Unit Masonry: 12%
 - 3. Interior Located Wood: 15 percent, measured in accordance with ASTM D2016.
 - 4. Concrete Floors: 7 percent.
- D. Beginning of installation means acceptance of existing surfaces.

3.02 PREPARATION

- A. Remove electrical plates, hardware, light fixture trim, and fittings prior to preparing surfaces or finishing.
- B. Correct minor defects and clean surfaces which affect work of this Section.
- C. Shellac and seal marks which may bleed through surface finishes.
- D. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- E. Aluminum Surfaces Scheduled for Paint Finish: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.
- F. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish: Remove foreign particles to permit adhesion of finishing materials. Apply latex based sealer or primer.
- G. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- H. Gypsum Board Surfaces: Latex fill minor defects. Spot prime defects after repair.
- I. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- J. Plaster Surfaces: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- K. Uncoated Steel and Iron Surfaces: Remove grease, scale, dirt, and rust. Where heavy coatings of scale are evident, remove by wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.
- L. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- M. Interior Wood Items Scheduled to Receive Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Apply sealant to all open cracks between adjacent so that paint will flow and seal all open gags.
- N. Exterior Wood Scheduled to Receive Paint Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior caulking compound after prime coat has been applied.
- O. Wood and Metal Doors Scheduled for Painting: Seal top and bottom edges with primer.

3.03 PROTECTION

- A. Protect elements surrounding the work of this Section from damage or disfiguration.

- B. Repair damage to other surfaces caused by work of this section.
- C. Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.
- D. Remove empty paint containers from site.

3.04 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Do not apply finishes to surfaces that are not dry.
- C. Apply each coat to uniform finish.
- D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- E. Sand lightly between coats to achieve required finish.
- F. Allow applied coat to dry before next coat is applied.
- G. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- H. Prime back surfaces of interior and exterior woodwork with primer paint.
- I. Prime back surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.
- J. After prime and first finish coat, Architect to inspect color. If contractor applies final finish coat, before Architect reviews first finish coat, the contractor will be required to repaint at no cost to the Owner.

3.05 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Paint shop primed equipment, including all new steel pipe hand railings and guard screens. Minimum of two additional coats required.
- B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- C. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports which occur in rooms and areas receiving paint.
- D. Replace identification markings on mechanical or electrical equipment when painted accidentally.
- E. Paint interior surfaces of air ducts, and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- F. Paint exposed conduit and electrical equipment occurring in finished areas.
- G. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

- H. Color code equipment, piping, conduit, and exposed ductwork in accordance with requirements indicated. Color band and identify with flow- arrows, names, and numbering.
 - I. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.
- 3.06 CLEANING
- A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.
 - B. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.
 - C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
- 3.07 SCHEDULE - SHOP PRIMED ITEMS FOR SITE FINISHING
- A. Metal Fabrications (Section 055000): Exposed surfaces of lintels, roof ladders, metal stairs, roof exhaust hoods, etc.
- 3.08 SCHEDULE - EXTERIOR SURFACES
- A. Wood - Painted
 - 1. One coat alkyd primer sealer.
 - 2. Two coats alkyd enamel, semi-gloss.
 - B. Concrete, Cement Plaster
 - 1. One coat block primer.
 - 2. Two coats latex, satin finish
 - C. Steel - Unprimed
 - 1. One coat zinc chromate primer.
 - 2. Two coats alkyd enamel, semi-gloss
 - D. Steel - Shop Primed
 - 1. Touch-up with zinc chromate primer.
 - 2. Two coats alkyd enamel, semi-gloss.
 - E. Steel - Galvanized
 - 1. One coat zinc chromate primer.
 - 2. Two coats alkyd enamel, semi-gloss.
 - F. Aluminum - Mill Finish
- 3.09 SCHEDULE - INTERIOR SURFACES
- A. Wood - Painted
 - 1. One coat alkyd prime sealer.
 - 2. Two coats alkyd enamel, semi-gloss.
 - B. Concrete, Concrete Block
 - 1. One coat block filler mixed with latex primer.
 - 2. Two coats alkyd, semi-gloss
 - 3. Where schedule calls for epoxy/ester, install instead of finish coats, 2 coats; 5'4" high on wall. Paint line to match block coursing
 - C. Steel - Unprimed
 - 1. One coat zinc chromate primer.
 - 2. Two coats alkyd enamel, semi-gloss.
 - D. Steel - Primed
 - 1. Touch-up with original primer.
 - 2. Two coats alkyd enamel, semi-gloss.
 - E. Steel - Galvanized
 - 1. One coat zinc chromate primer.
 - 2. Two coats alkyd enamel, semi-gloss.
 - F. Plaster, Gypsum Board

1. One coat latex primer-sealer.
2. Two coats alkyd, semi-gloss.

3.10 SCHEDULE - COLORS

- A. Color Schedule to be submitted by Architect prior to prime coating procedures. Note architect will inspect and approve colors upon first finish coat. If final coats are applied without architect inspection, finish coats may have to be redone at contractor's expense.

END OF SECTION 099000

SECTION 220100 - GENERAL PROVISIONS FOR MECHANICAL WORK

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. This section covers the general arrangement of the mechanical systems and related items to complete the work as shown on the drawings and as specified herein.
- B. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- C. The Contractor shall familiarize himself with the work of all other trades, general type construction and the relationship of his work to other sections. He shall examine all working drawings, specifications and conditions affecting his work. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, verify all dimensions in the field and advise the Engineer of any discrepancy before performing any work.
- D. The work shall include complete testing of all equipment and piping at the completion of the work and making any minor connection changes or adjustments necessary for the proper functioning of the system and equipment.
- E. The Contractor shall perform all necessary temporary work during construction.
- F. Work under this section shall conform to all governing codes, ordinances and regulations of the City, County and State.
- G. The Contractor shall be responsible for all errors in fabrication, for the correct fitting, installation and erection of the various mechanical systems as shown on the drawings.

1.2 DRAWINGS AND SPECIFICATIONS

- A. Contract drawings for work under this section are in part diagrammatic, intended to convey the scope of work and indicate the general arrangement of equipment, ducts, piping and the approximate size and location of equipment and outlets. The Contractor shall follow these drawings in laying out his work and shall verify spaces in which his work will be installed, indicating to the Engineer where any conflicts or overlapping of systems occur.
- B. Where job conditions require reasonable changes in indicated locations and arrangement, proposed departures shall be submitted with detailed drawings to the

**Carver Community Center Renovation
FOA 1201**

Engineer for approval before any of the proposed work is commenced. All approved departures shall be made at no additional cost to the Owner.

- C. The drawings and the specifications are intended to indicate complete and working systems, unless specifically indicated to the contrary. The work includes the furnishing, installing and connecting of a complete working installation in each case to the full extent set forth in the drawings and herein specified. The Contractor shall be responsible for the complete functioning system, unless specifically noted otherwise.
- D. The drawings and specifications shall be considered as cooperative, work and material included in either, though not mentioned in both, shall be a part of the work to be accomplished and shall be carried out completely in as thorough manner as if covered by both.
- E. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories that may be required. The Contractor shall carefully investigate the structural and finish conditions affecting all his work and shall arrange such work accordingly, furnishing such fittings, pipe, traps, valves and accessories as may be required to make a functional installation at no additional cost to the Owner.

1.3 EQUIPMENT DESIGN AND INSTALLATION

- A. The design, manufacture, testing and method of installation of all apparatus and materials furnished under the requirements of these specifications shall conform to the applicable standard rules of the following. Where materials are not specifically referred to, but are required, they shall meet the requirements of the applicable code.

NEMA	-National Electrical Manufacturer's Assoc.
UL	-Underwriter's Laboratories, Inc.
ASME	-American Society of Mechanical Engineers
ASTM	-American Society of Testing Materials
ASHRAE	-American Society of Heating, Refrigerating and Air Conditioning Engineers
BOCA	-Building Officials & Code Administrators International, Inc.
NFPA	-National Fire Protection Association
AWWA	-American Water Works Association
AWS	-American Welding Society
AMCA	-Air Moving and Conditioning Assoc.
ANSI	-American National Standards Institute
NEC	-National Electrical Code
AIEE	-American Institute of Electrical Eng.
ARI	-Air Conditioning & Refrigeration Institute
SMACNA	-Sheet Metal and Air Conditioning Contractors National Assoc.

**Carver Community Center Renovation
FOA 1201**

LSDHBC	-Local and/or State Division of Housing, Building and Construction
SPC	-State Plumbing Code
NPC	-National Plumbing Code
OSHA	-Occupational Safety and Health Adm.
EPA	-Environmental Protection Agency
DOE	-U.S. Department of Energy
IMC	-International Mechanical Code
IECC	-International Energy Conservation Code

- B. Unless otherwise specified, equipment and materials of the same type and used for the same purpose, shall be products of the same manufacturer.

1.4 CAPACITIES AND OPERATING CONDITIONS

- A. Capacities, sizes and conditions specified or shown on drawings shall be regarded as minimum allowable. If the Contractor proposes to furnish any equipment which would have to operate at other than specified conditions to produce final effects, all other directly or indirectly related components of the entire systems (as well as of the structure, finish and other systems in the building) must be properly coordinated to the satisfaction of the Engineer. That is: Operating conditions through the entire system must be such that no motor is overloaded, no equipment operates noisier, faster, or hotter than manufacturer's publication recommends and that no excess stress or demand is imposed on any component of any system or the structure; also that no quality, architectural feature, function or "end result" is affected adversely, in the opinion of the Architect.

1.5 LAYOUT

- A. The Contractor's work lines and established heights shall be in strict accordance with drawings and specifications insofar as these drawings and specifications extend. The Contractor shall verify all dimensions shown and establish all elevations and detail dimensions not shown. He shall also correlate the time so that the work will proceed to the best advantage of the complete job as a unit. The Contractor shall be responsible for furnishing in ample time, any information required to revise footing elevations, build all chases and openings in floors, walls, partitions, ceilings, and roofs to provide clearance which may be required to accommodate the work. The contractor shall set all sleeves, anchor bolts and inserts required to accommodate his equipment before masonry is constructed.
- B. The Contractor shall layout his work well enough in advance to foresee any conflicts or interferences with work of other sections so that in case of interference, his layout may be altered to suit the conditions, prior to the installation of any work. This procedure will require constant coordination with all sections of the work.

**Carver Community Center Renovation
FOA 1201**

1.6 CUTTING AND PATCHING

- A. All cutting and patching required in connection with the installation of this work, and work due to errors, defective work, ill-timed work or tardiness in properly designating size and location in sufficient time or by failure to notify other trades, shall be done under this section, but only in the manner directed by the Engineer so as to prevent or minimize damage to installed work. Damage as a result of cutting for installation, shall be repaired by mechanics skilled in the trade involved, at no additional expense to the Owner.
- B. No cutting of structural members will be permitted, except when prior permission of the Engineer has been obtained. This work must conform in every respect to the surrounding finish and to the quality of workmanship and materials used.
- C. Piercing of any waterproofing or roofing shall be done only by the trade involved. After the part piercing the waterproofing has been set in place, the opening made for this purpose shall be filled and made absolutely watertight to the satisfaction of the Engineer.
- D. See Section: 220510 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1.7 OPERATING INSTRUCTIONS

- A. After all tests have been completed and work accepted by the Owner, a competent representative shall, at a time determined by the Engineer, present verbal and visual instructions to the Owner's personnel in the proper operation of his respective system. For this purpose, each section of work shall be demonstrated and explained to the Owner's personnel and sufficient time allotted for instructions. See Specification Section 220600.
- B. The Contractor shall provide, mounted under framed glass, a copy of the master valve chart and a copy of the master control diagram for the entire building.

1.8 SAFETY

- A. The contractor and his subcontractors for the project shall comply with all applicable Federal, State, and local laws governing safeguards, safety devices, and protective equipment and shall take all other needed actions which they may determine or which the Department may determine to be reasonably necessary to protect the life and health of all employees and personnel on the project, provide for the safety of the public and protect all property affected by the performance of the work covered by the contract.
- B. As provided in KRS Chapter 338 in the Kentucky Occupational Safety and Health Act and in subsequent regulations and standards promulgated by the Kentucky Occupational Safety and Health Standards Board, neither the Contractor nor his

**Carver Community Center Renovation
FOA 1201**

subcontractors shall require any laborer or mechanic employed in performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.

- C. The contractor shall not remove or disturb any suspected hazardous materials, including asbestos-containing materials, lead based paints, electrical equipment containing PCB's, or any other except as instructed in this contract. If any material not covered by the contract is encountered, notify the Engineer immediately.

1.9 TESTS - GENERAL

- A. All tests required to establish the adequacy, quality, safety, completed status and suitable operation of each system and all components thereof shall be made in the presence of and to the satisfaction of the Engineer or his authorized representative and other representatives of State and local Government. All instruments, labor and expert service necessary to conduct these tests shall be supplied by the Contractor; power and fuel will be furnished by the Owner.
- B. The final inspection and tests are to be made only after the Engineer is satisfied that the work described in these specifications has been completely installed in accordance with the true spirit and intent of these specifications and that complete preliminary tests were made which indicate adequacy, quality, completion and satisfactory operation. The acceptance of the work herein specified, shall not in any way prejudice the Owner's right to demand replacement of defective material and/or workmanship.

1.10 WARRANTY

- A. All equipment shall be warranted for a period of at least one (1) year from the date of acceptance, as evidenced by date of substantial completion for the entire project or for the last phase of the project, whichever occurs later, against defective materials, design, and workmanship. In addition to the equipment warranty, the Contractor shall provide all repair and adjustment service necessary for the proper operation of the entire system for a period of one (1) year after the date of acceptance, as evidenced by the date of substantial completion for the entire project or for the last phase of the project, whichever occurs later. Upon receipt of notice from the Owner's representative of failure of any part of the warranted system or equipment during the warranty period, the affected part shall be replaced promptly with a new part without cost to the Owner. Upon failure to take action within 24 hours after being notified, the work will be accomplished by the Engineer at the expense of the Contractor. See General Conditions and individual equipment specifications. Note that the warranty period of time specified in this section represents the minimum warranty period required for work performed under specification Division 21, 22 and 23. Where the General Conditions and/or individual equipment/system specifications require a warranty

**Carver Community Center Renovation
FOA 1201**

period of longer duration or earlier start date than specified in this paragraph, the longer duration/earlier start date shall supercede for those portions of work covered by that specification. In the event the contractor is notified of warranty issues but does not correct or address the warranty issues prior to the end of the specified warranty period, the contractor will not be relieved of the responsibility to correct the deficient items after the warranty end date has passed.

1.11 ELECTRIC MOTORS

- A. All motors shall be designed, tested and applied in accordance with the applicable standards listed hereinbefore. Motors shall be of sufficient size for the duty to be performed and shall not exceed the full load rating when the driven equipment is operating at specified capacity. Unless otherwise specified, all motors shall be high efficiency type and shall have open frames and continuous-duty classification based on 50 degrees C. ambient temperature. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics. Motors shall meet NEMA high efficiency standards MGI - 1.41.2 for energy efficient polyphase squirrel-cage motor. Efficiency shall be in accordance with MGI - 1.2.55. When motor horse powers required differ from those indicated on the drawings, the Contractor shall make the necessary adjustments to the wiring, disconnect devices, starters and branch-circuit protection at no additional cost to the Owner.

Motors shall be rated for continuous duty capable of driving the connected loads without exceeding temperature limitations of the motor insulation. Special Class A moisture-resisting insulation (designed to operate in a 50 degree C. ambient without exceeding a temperature rise rating designated by NEMA for the type of enclosure used) shall be utilized in each motor.

- B. Unless otherwise indicated or specified, the electrical components required to operate mechanical equipment, such as, motors, float and pressure switches, solenoid valves, and other devices functioning to control the mechanical equipment, shall be furnished as part of the mechanical equipment, shall be complete and operable, and shall be included under this section of the specifications. All motor starters not part of a motor control center shall be included under this Section and shall be the hand off auto type with 3 over-loads on 3 phase units and 120V control transformer. Conduit and wires required for external electrical connections shall be furnished and are specified under DIVISION 26 - ELECTRICAL. Integral phase failure relay shall be provided as a part of all three phase motor starters. Relay shall shut motor down on phase loss or phase unbalance and automatically reset when normal phasing is restored. Phase failure relay shall have adjustable restart time capabilities. Mechanical contractor shall coordinate staggered restart times as required.

1.12 FEES, PERMITS AND INSPECTION

**Carver Community Center Renovation
FOA 1201**

- A. The Contractor shall secure and pay for all tap fees, permits, licenses, insurance and inspections required for the execution of the work on the project and deliver to the Engineer all certificates related to and issued by the authorities having jurisdiction. These include a certificate of final approval from the Underwriters' Inspection Bureau having jurisdiction, pursuant to all electrical work, a certificate of inspection and approval from the State Division of Plumbing and/or local authorities pursuant to all plumbing work and the State Boiler Inspector.

1.13 AS-BUILT DRAWINGS

- A. The Contractor shall deliver to the Engineer at the completion of the work, one (1) print of "As-Built" drawings, showing legibly and accurately, plumbing, heating, ventilating and piping systems with equipment locations shown as actually installed. Changes in original plans shall be neatly shown in red pencil. Each print shall be signed by the sub-contractor who has done the work.
- B. During construction the Contractor shall retain a set of blue line drawings on the site for recording all changes. These drawings shall be available for inspection by the Engineer.

1.14 FINAL TEST, OPERATION AND ACCEPTANCE

- A. In addition to any other testing specified, the Contractor shall perform the following tests and place the system(s) in operation to demonstrate that all features of the system(s) including instrumentation, controls and equipment function as specified for final acceptance.
- B. Heating, Ventilating, and Cooling System
 - 1. At such time as the Engineer determines that the new heating, ventilating and cooling system is ready to be placed into service, the Contractor shall place the new equipment in operation and demonstrate that the safety devices are in proper working order to the satisfaction of the Engineer.
 - 2. The Contractor shall then maintain operation and demonstrate each system's capability of producing at full load capacity. Within 24 hours after the systems have been satisfactorily tested, Owner operating personnel will relieve the Contractor of the operations and the Contractor shall continue his work on a joint occupation basis.
 - 3. Depending on the status of the work, the Contractor may at his option conduct other required tests concurrent with, prior to, or following the system testing, providing the Engineer is satisfied the installation is in conformance with the specifications. However, all features of the system(s) shall be tested individually for proper operation at partial and full load conditions and collectively where normal operations require the

**Carver Community Center Renovation
FOA 1201**

several components to operate concurrently to constitute an acceptable system.

- C. Where a specific test period is not stipulated in the specifications, the equipment shall operate at full load until normal operating temperatures are reached and continue to operate for a minimum of one (1) hour at full load to confirm that the equipment conforms to all specification requirements such as capacity, overload, overheating, vibration, noise, etc.
- D. Where ambient conditions preclude attaining full load in normal operation, the Contractor shall provide induced conditions which will allow achieving full load.
- E. Final acceptance of the entire installation will be based on an acceptable demonstration that all components, local and remote, respond to safety manual and Automatic System controls. During this test the Contractor shall cause simulated perturbations for which the control system is designed to respond. All control, monitor and readout points in the system shall function properly before final acceptance is made.
- F. Filters: Provide 30% efficient pleated filters for all equipment utilizing filters. The contractor shall be responsible for changing the air filters once the equipment has been started until substantial completion of the entire project. During this time period, filters shall be changed every 30 days with dated 30% efficient filters. New dated filters shall be installed when the systems are balanced. One complete set of filters shall be turned over to the owner at substantial completion of the entire project as a spare set.

1.15 CONTRACTOR FURNISHED DRAWINGS, DESCRIPTIVE DATA AND MANUALS

- A. Approval of Materials and Equipment: Within 30 days of receipt of notice to proceed, and before starting installation, the Contractor shall submit to the Architect for approval, in triplicate, lists of materials, fixtures and equipment to be incorporated in the work. If departures from the contract drawings are deemed necessary by the Contractor, details of such departures, including changes in related portions of the project and the reasons therefore shall be submitted with drawings. Where such departures require piping or equipment to be supported otherwise than shown, the details submitted shall include loadings and type and kinds of frames, brackets, stanchions, or other supports necessary. Approved departures shall be made at no additional cost to the Owner. The lists of materials and equipment shall be supported by sufficient descriptive material, such as catalog cuts, diagrams, and other data published by the manufacturer, as well as evidence of compliance with safety and performance standards, to demonstrate conformance to the specification requirements; catalog numbers alone will not be acceptable.
- B. Conformance to Agency Requirements: Where materials or equipment are

**Carver Community Center Renovation
FOA 1201**

specified to be constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers, the Air Moving and Conditioning Association, or the American Society of Heating, Refrigerating and Air Conditioning Engineers, or to be approved by the Underwriters' Laboratories, Inc., the Contractor shall submit proof that the items furnished under this specification conform to such requirements. A certificate or published statement by the manufacturer will be sufficient evidence that the item conforms to the requirements of ASHRAE. In lieu of such stamp, certificate, or statement, the Contractor may submit written certificate from any nationally recognized testing agency adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the requirements listed hereinbefore, including methods of testing, of the specified agencies.

C. SHOP DRAWINGS

1. In accordance with the General Conditions, shop drawings shall be submitted on all units of prefabricated materials. Shop drawings shall show, in detail, all parts of the work, fully dimensioned and shall also indicate construction, concealed and other jointing, thickness of materials, method of anchoring and attachment to other materials. Where required for certain work, submit setting and bending diagrams and mark same to correspond with the design drawings, identifying locations of various items. Show types, sizes and locations of sleeves and inserts.
2. The Contractor shall check all shop drawings for completeness and for correctness before submitting the drawings. If major corrections are required on the drawings, the Contractor shall return the drawings to the originator and have the changes made. The Contractor shall indicate his corrections on the prints in green pencil and sign all prints and other material sent to the Engineer.
3. Detail and Erection Drawings: Detail and erection drawings for equipment, piping and other items of this nature shall be carefully prepared in accord with standard practice and shall show erection plans and member details with all individual parts identified on both the detail sheets and erection plans. All identification markings shall be carefully preserved until after the erection process is completed.
4. Material Data: The Contractor shall submit descriptive data, as required, on pipe, fittings and valves to be incorporated into the work. This data shall be in sufficient detail to allow the Engineer to determine that the pipe, fittings and valves meet the requirements of the contract drawings and specifications or that they are an acceptable equal to that specified. All data shall be in the form of manufacturer's or supplier's literature concerning the product and shall indicate catalog number, conditions of use, application instructions, and/or other information as applicable.

5. Equipment Data: The Contractor shall submit descriptive data on all items of equipment to be furnished and installed under this contract. These submittals shall consist of manufacturer's published catalog information which completely describes component materials, configuration and rough-in data for mechanical and electrical equipment shall also include cuts, diagrams, characteristic curves and capacity information as applicable. Where more than one item of equipment is employed in the same system, the submittal of equipment data will include special diagrams showing the electrical wiring, interconnecting piping, related controls and relation and operation of the various items of equipment for the entire system.

D. OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS, ETC.

1. At completion of the contract, the Owner shall be provided with three (3) bound copies of operations and maintenance instructions, recommended list of spare parts required for a period of one (1) year and a list of any special tools required to maintain the equipment for the various items of the HVAC and plumbing equipment, including fire suppression sprinkler system, etc. Where special tools are required, the Contractor shall furnish two (2) of each such tools to the Owner at no additional contract cost.
2. In addition to manufacturer's approved shop drawings, manual shall include: (a) A listing of equipment (identified in accordance with the drawings nomenclature, eg. RTU-1, HP-1, P-1, etc.) and distribution or supplier of the equipment.
3. Instructions shall be included for routine checking of all items requiring continued maintenance.
4. Schematic drawings with actual pieces of HVAC and plumbing equipment, etc., shall be included; where manufacturers parts numbers only are applicable, they shall be included.
5. Detailed operating instructions for HVAC and plumbing equipment shall be included, as well as general maintenance procedures to be followed on such equipment. Manufacturers maintenance and operation manuals will be required where such are normally available with the equipment, but as such information is often of a general nature and applicable to various models of equipment, such information shall be supplemented by specified typed directions for the particular piece of equipment applicable to this project.

E. MATERIALS, EQUIPMENT AND APPLIANCES

**Carver Community Center Renovation
FOA 1201**

1. **Materials:** All materials, equipment, products and incidentals to be furnished by the Contractor shall be new, unless otherwise specified, undamaged and the first line quality product of the manufacturer and/or supplier, except when competitive grades fully meet the standards specified in the various technical sections of these specifications.
2. **Standard Products:** Except as otherwise approved by the Engineer, the equipment and appliances to be furnished under these specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design. Where two or more units of the same type and class of equipment are required, the units shall be the product of the same manufacturer and shall be identical insofar as possible. The component parts of the products need not be products of one manufacturer.
3. **Manufacturer's Directions:** Where manufacturer's instructions or recommendations are applicable to the installation or application of materials, the Contractor shall adhere to strict conformance with such instructions or recommendations unless specifically noted to the contrary in these specifications. Where such directions are in conflict with the drawings and specifications, the Contractor shall inform the Engineer of such conflict and request instructions.
4. **Samples:** The Contractor shall furnish, for approval, samples of materials, profiles, designs, finishes, etc., which are either required by the various sections of specifications or which the Engineer may request from time to time. Samples shall be clearly identified with adequate information for the Engineer's evaluation.
5. **Materials and Equipment Delivered to Jobsite:** All items of materials, equipment, supplies and miscellaneous items to be incorporated into the work shall be delivered to the jobsite with labels, tags, nameplates and/or containers which clearly indicate the manufacturer's item or catalog number or conformance with the applicable standards stipulated in the technical sections of the specifications. Any item which cannot be verified in the field shall not be included in the work until its identity can be established by the Engineer.

F. EQUIPMENT AND MATERIAL SUBSTITUTIONS

1. Should the Contractor elect to use and install materials which have been approved for use other than specified, he shall be required to make any necessary changes, perform all work and furnish any additional materials and ancillary equipment required to make such substituted materials or equipment function or perform as that specified, at no cost to the Owner. This includes structural, electrical and/or other affected trades.

**Carver Community Center Renovation
FOA 1201**

1.16 DEFINITIONS

- A. Mechanical Contractor: Any contractor whether bidding or working independently or under the supervision of a general contractor and/or construction manager and who installs any type of mechanical work (controls, plumbing, HVAC, sprinkler, gas systems, etc.).
- B. Mechanical Sub-Contractor: Any contractor contracted to or employed by the mechanical contractor for any work required by the mechanical contractor.
- C. Engineer: The consulting mechanical/electrical engineers either consulting to the owners, architects, other engineers, etc. In this case KTA, Inc.
- D. A-E: Shall construe architect and/or engineer. In all situations that involve an architect, it shall construe architect, in all others, engineer.
- E. Furnish: Deliver to the site in good condition and turn over to contractor responsible for installation.
- F. Provide: Furnish and install in complete working order.
- G. Install: Install equipment furnished by others.
- H. Indicated: Shown on the drawings or addenda thereto.
- I. Contract Documents: All documents pertinent to the quality and quantity of work to be performed on the project. Includes but not limited to: plans, specifications, instructions to bidders, general and special conditions, addenda, alternates, list of materials, list of sub-contractors, unit prices, shop drawings, field orders, change orders, cost breakdown, periodical payment requests, etc.

1.17 INTENT

- A. It is the intention of these specifications and all associated drawings to call for finished work, tested and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use".
- B. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

PART 2 - PRODUCTS

NOT APPLICABLE

**Carver Community Center Renovation
FOA 1201**

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION 220100

SECTION 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
1. General equipment requirements
 2. Dielectric fittings
 3. Sleeves
 4. Escutcheons
 5. Firestopping
 6. Smokestopping
 7. Drives
 8. Roof Curbs
 9. General piping requirements
 10. Demolition

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.

1.3 GENERAL REQUIREMENTS

- A. All equipment shall be properly aligned, leveled and adjusted for satisfactory operation. Equipment shall be installed so that the connecting and disconnecting of piping and accessories can be done readily and so that all parts are easily accessible for inspection, operation, maintenance and repair. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening and shall be supported by a service organization that is, in the opinion of the Architect reasonably convenient to the site.

1.4 IDENTIFICATION

- A. Permanent and legible engraved tags, brass or laminated plastic, shall be installed on all switches, pumps, main valves, and controls, using the same nomenclature as appears on record drawings, diagrams and typewritten or printed operating instructions. A permanent index thereto shall be provided in triplicate, one copy of which shall be mounted under framed glass. Each major component of equipment shall have the manufacturer's name, address and catalog number on a metal plate securely attached to the item of equipment. The nameplate shall be easily readable

**Carver Community Center Renovation
FOA 1201**

and not obscured during the period of construction by painting, plastering, insulating or other work.

1.5 PREVENTION OF RUST

- A. Surfaces of ferrous metal shall be given a rust inhibiting coating where specified. Coal-tar or asphalt-type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot dip galvanized after fabrication, mill galvanized sheet steel may be used, provided all raw edges are painted.

1.6 PROTECTION FROM MOVING PARTS

- A. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded.

1.7 PROTECTION OF EQUIPMENT AND MATERIALS

- A. After delivery, before and after installation, equipment and materials shall be protected against weather theft, injury or damage from all causes.
- B. Plumbing fixtures and other equipment with enameled or glazed surfaces shall be protected from damage by covering and/or coating, as recommended in bulletin Handling and Care of Enameled Cast Iron Plumbing Fixtures, issued by Plumbing Fixtures Manufacturers' Association.
- C. Where marring or disfigurement has occurred, the Contractor shall replace or refinish the damaged surfaces as directed and to the satisfaction of the Architect.
- D. Pipe and duct openings shall be closed with caps or plugs during installation.

1.8 MATERIALS

- A. Materials specified herein shall conform to the respective publications and other requirements specified in the following paragraphs and as shown on the drawings. Other materials shall be the products of manufacturers regularly engaged in the manufacture of such products. Types, grades, schedules and pressure and temperature ratings for a particular service shall be as specified hereinafter and other sections of these specifications.
- B. Unless specifically noted to the contrary, all valves, strainers and accessories listed in these specifications shall be "rated" devices (i.e. 125 lb. steam - 200 lb. water, oil or gas), selected for the proper use and conditions of the system for which they are to be installed. Under no circumstances shall the contractor be relieved of the responsibility of the valve rating by the installation of valves of lesser quality. All valves shall have rising stems, except that ball valves, plug valves, butterfly valves

**Carver Community Center Renovation
FOA 1201**

and other similar types shall have clear indicators for valve positions. Non-rising stem valves, and non-rated valves shall not be used.

PART 2 - PRODUCTS

2.1 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder joint, plain or weld-neck and connections that match piping system materials.

2.2 SLEEVES

- A. Steel: Galvanized, plain ends, ASTM A 53, Type E, Grade B, Schedule 40.
- B. Cast Iron: Equivalent to ductile iron pressure pipe with plain ends.

2.3 ESCUTCHEONS

- A. Chromium-plated iron or chromium-plated brags, either one piece or split patterns, held in place by internal spring tension or set screw that completely covers opening.

2.4 FIRE STOPPING

- A. Asbestos free materials classified by UL to provide Fire Barrier equal to time rating of construction being penetrated and complying with applicable codes and have been tested in accordance with UL 1479 or ASTM E-814.

2.5 DRIVES

- A. Each belt-connected motor-driven unit or fan shall be provided with a variable pitch V-belt drive.
- B. Sheaves shall be of cast iron or of steel, statically and dynamically balanced, bored to fit properly on the shafts and secured with key of proper size. Sheaves having set screws alone will not be permitted. Sheaves shall be variable pitched and shall be designed to give the required rpm at approximately the midposition of adjustment. Pitch diameters of sheaves shall be not less than 3.0 inches for "A" section belts; 5.4 inches for "B" section belts; 9.0 inches for "C" section belts; and 13.0 inches for "D" section belts.
- C. Belts shall be selected for a minimum service factor of 1.5 (based on motor nameplate horsepower), and selected and matched in sets for equal tension.
- D. All other drives shall be as described under the respective equipment paragraph of these Specifications, as applicable.

**Carver Community Center Renovation
FOA 1201**

2.6 ROOF CURBS

- A. Roof curbs shall be fabricated for complete compatibility with roof panels and framing system. Size and design as required to support vent unit and to adequately divert storm drainage. Provide all sealants, closures, etc. as required for complete installation. Provide roof subframing and/or headers between roof bar joists to provide continuous rigid perimeter support for the curb.
- B. Prefabricated roof curbs shall be constructed of galvanized sheet steel, 16 or 14 gauge as required with corners mitered and continuously welded. Provided integral water diverter with seams continuously welded. Provide internal reinforcing as required. Factory insulate curbs with 1 ½" thick 3 lb. density fiber glass insulation. Top of curb shall be level with pitch built into curbs.
- C. Mechanical contractor shall coordinate with the roofing contractor to insure compatibility of the systems and for proper installation. Provide shop drawings to roofing contractor for review and coordination.
- D. The mechanical contractor is responsible for installing the curb and framing. Roofing contractor is responsible for attaching roofing to the curb. Both contractors will be held responsible for leaks.
- E. Top of roof curb to be installed at a minimum of 12" above the adjacent finished roof surface.

PART 3 - EXECUTION

3.1 PIPING

- A. Pipe shall be cut accurately to measurements established at the jobsite and worked into place without springing or forcing, properly clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Piping and equipment supports shall be provided. Supports shall be attached only to structural framing members and concrete beams or slabs at approved locations with approved connections. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided and detailed. Pipes shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints or hangers. Changes in direction shall be made with fittings. All piping shall be installed with sufficient pitch to insure adequate drainage and venting. Piping connections to equipment shall be provided with unions or flanges. Ferrous piping and copper piping shall be electrically isolated from each other with dielectric couplings or fittings.

3.2 WORKMANSHIP

**Carver Community Center Renovation
FOA 1201**

- A. General: All materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer to conform with the contract documents. The installation shall be accomplished by workmen skilled in this type of work.
- B. Screw joints shall be made with tapered threads properly cut. Joints shall be made tight with a stiff mixture of litharge and glycerin, or polytetrafluorethylene tape, or other approved thread joint compound applied to the male threads only. Not more than three threads shall show after the joint is made up.

3.3 WELDING AND BRAZING

A. Welders Qualification

- 1. Welder's qualifications shall specify results of test, or retest, positions qualified and type of welding in which qualified.
- 2. All welds shall be of sound metal thoroughly fused to the base metal at all points, free from cracks; and reasonably free from oxidation, blow holes, and non-metallic inclusions. No fins or weld metal shall project within the pipe; and should they occur shall be removed. All pipe beveling shall be done by machine. The surface of all parts to be welded shall be thoroughly cleaned free from paint, oil, rust or scale, at the time of welding except that a light coat of oil may be used to preserve the beveled surfaces from rust.
- 3. All pipe and fittings shall be carefully aligned with adjacent parts and this alignment must be preserved in a rigid manner during the process of welding.
- 4. It is required that all welding of piping covered by this specification, regardless of conditions of service, be installed as follows:
 - a. Pipe welding shall comply with the provision of the latest revisions of the applicable code whether ASME "Boiler Construction Code", ANSI "Code for Pressure Piping", AWS and/or Kentucky KRS-236 "Boiler Safety Law". The contractor shall make arrangements for inspection visits by the state boiler inspector as required by KRS-236.
 - b. The Contractor's welding procedure shall clearly set forth P-numbers of parent metal to be welded, rod or filler metal to be used and positions required.
 - c. Before any pipe welding is performed, the Contractor shall submit to the Architect a copy of his welding procedure specifications together with proof of its qualification as outlined and required by the most recent issue of the code having jurisdiction.

**Carver Community Center Renovation
FOA 1201**

- d. Before any operator shall perform any pipe welding, the Contractor shall also submit to the Architect, the operator's qualification record in conformance with provisions of the Code having jurisdiction, showing that the operator was tested under the approved procedure specification submitted by the Contractor.
 - e. Welding work shall not be performed by welders who are not approved by the Architect and any such work performed shall be summarily removed and replaced without further recourse by the Contractor.
 - f. Standard Procedure Specifications and operators qualified by the National Certified Pipe Welding Bureau shall be considered as conforming to the requirements of the specifications.
 - g. Each manufacturer or Contractor shall be responsible for the quality of welding done by his organization and shall repair any work not in accordance with these specifications.
 - h. Brazing, when specified or indicated on the contract drawings, shall be in accordance with Part UB of Section VIII of the ASME Code. Filler metal shall conform to AWS B260, Class B AG-1 or B AG-2. Procedure and performance qualification requirements for brazing shall be the same as for welding, as required above.
5. Flanges and Unions shall be faced true. Flanges shall be provided with 1/16 inch composition gasket, unless otherwise specified, and made square and tight. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Gaskets shall conform to ANSI Standard B16.21.
6. Valves in horizontal lines shall be installed with stems horizontal or above. Isolation valves shall be installed on each side of each piece of equipment such as pumps, and other similar items; and at any other points indicated or required for draining, isolation, or sectionalizing purposes.

3.4 PIPE SLEEVES

- A. General: Pipes passing through concrete or masonry walls or concrete floor or roofs shall be provided with pipe sleeves fitted into place with epoxy sealing grout at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. Each sleeve shall extend through its respective wall, floor or roof, and shall be cut flush with each surface, except sleeves through floor where not in chase shall extend 1/4 inch above finished floor. Unless otherwise indicated, sleeves shall be of such size as to provide a minimum of 1/4 inch all

**Carver Community Center Renovation
FOA 1201**

around clearance between bare pipe and sleeves or between jacket over insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve shall be sealed as specified.

- B. Sleeves are not required for core drilled holes.
- C. Pipes Passing Through Waterproofing Membranes: Pipes passing through floor waterproofing membrane shall be installed through a 4-pound lead-flashing sleeve, or a 0.032-inch thick aluminum sleeve, each with an integral skirt or flange. Flashing sleeve shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall set over the floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 1 inch above the floor. The annular space between the flashing sleeve and the metal-jacket-covered insulation shall be sealed. At the Contractor's option, pipes passing through floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and a pressure ring with brass bolts. Waterproofing membrane shall be clamped into space and sealant shall be placed in the caulking recess.
- D. Pipes Passing Through Roof: Pipes passing through the roof shall be installed where shown on the drawings. Any penetration in roof shall be approved by the Roofing Manufacturer.

3.5 ESCUTCHEONS

- A. Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used.

3.6 TESTS

- A. General: All tests shall be conducted in the presence of the Engineer who shall be given 2 days notice before any test is to be conducted. Any utilities, materials, equipment, instruments, and personnel required for the tests shall be provided by the Contractor.
- B. Piping: After cleaning, all piping (except soil, waste and vent piping) shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure but not less than 100 psi for a period of time sufficient to inspect every joint in the system and in no case less than 2 hours. No loss of pressure will be allowed. Leaks found during tests shall be repaired by rewelding or replacing pipe or fittings. Caulking or peening of joints or fittings will not be permitted. Concealed and insulated piping shall be tested in place before covering or concealing.

**Carver Community Center Renovation
FOA 1201**

3.7 CLEANING

- A. General: Clean all piping and equipment systems as required to leave the piping and equipment clean and free from scale, silt, contamination, etc., as normally required and as specified herein.
- B. Utilities and Equipment: The Contractor shall provide all necessary temporary materials and equipment to clean the piping and equipment installed under this specification. No permanent equipment shall be used for storage, mixing, settling, compressing, pumping, etc., without the approval of the Architect. The Contractor shall supply a separate and independent source of clean, dry, oil-free air for the blowdown of systems requiring this method of cleaning.
- C. Use of Chemicals: No chemicals, wetting or drying agents shall be used to clean systems or equipment where the materials of the system undergo any changes in their physical or structural characteristics. In case of any doubt as to the compatibility of any materials to the cleaning solution used, the Contractor shall obtain prior written approval for the use of the solution from the manufacturer of the equipment. Piping systems, equipment and sub-assemblies shall be cleaned after completion of welding, machining, threading, testing and any other operations capable of contaminating the system piping or equipment.

3.8 FIRESTOPPING

- A. Firestopping shall be provided around all pipe, duct and chimney penetrations of fire rated floors, masonry walls and other fire rated walls and ceilings.
- B. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust or other substances that may affect proper fitting, adhesion, or the required fire resistance.
- C. Install penetration seal materials in accordance with manufacturer's instruction.
- D. Seal holes or voids may be penetrations to ensure an effective smoke barrier.
- E. Protect materials from damage on surfaces subject to traffic.
- F. Stop insulation flush with wall on insulated pipe and seal edges.

3.9 SMOKE-STOPPING

- A. Smoke-stopping shall be provided around all pipe, duct and chimney penetrations through floor or floor/ceiling assemblies and any other smoke walls or barriers.
- B. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust or other substances that may affect proper fitting, adhesion, or

**Carver Community Center Renovation
FOA 1201**

the required fire resistance.

- C. Install penetration seal materials in accordance with manufacturer's instruction.
- D. Seal holes or voids may be penetrations to ensure an effective smoke barrier.
- E. Protect materials from damage on surfaces subject to traffic.

3.10 DEMOLITION AND SCHEDULE

- A. All existing mechanical equipment noted on drawings and listed herein that is to be removed or demolished, shall be removed on schedule and disposed of as hereinafter directed.
- B. All items removed shall become the property of the contractor and shall be immediately disposed of off site at contractor's expense except as noted on drawings unless otherwise directed by owner.
- C. All demolition shall be carefully accomplished in accordance with master construction schedule so as not to remove any item required for support operation during the planned schedule. No item shall be removed until full schedule is worked out with contractors according to owners demands and agreed to in writing by the Engineer.
- D. Storage will be arranged during scheduling process. Contractors to provide own storage and security.
- E. Contractor doing the demolition of equipment must conform to the Clean Air Act of 1990. Refrigerant must be recovered from any air conditioning or refrigeration equipment prior to disconnecting and disposal. The contractor must own and use recovery equipment to meet this requirement. The contractor will be responsible for disposal of refrigerant, refrigerant oil or equipment.
- F. If pipe, insulation or equipment to remain is damaged in appearance or is unserviceable, remove damage or unserviceable portion and replace with new products of equal capacity and quality.

END OF SECTION 220500

**Carver Community Center Renovation
FOA 1201**

SECTION 220510 - SLEEVING, CUTTING, PATCHING AND REPAIRING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes requirements for the Mechanical Contractor related to sleeving, cutting, patching, and repairing associated with mechanical work.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS

PART 2 - PRODUCTS

2.1 SLEEVES

- A. See section 220500 for sleeve specifications.

2.2 LINTELS

- A. See Section 220530 for miscellaneous metals specifications.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for all openings, sleeves, trenches, etc., that he may require or create by demolition in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the General Contractor, any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the Contractor.
- B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through the walls, floors and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go throughout; however, when this

**Carver Community Center Renovation
FOA 1201**

is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

- C. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.
- D. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.
- E. All work improperly done or not done at all as required by the Mechanical Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

3.2 SLEEVES

- A. See Section 220500 for procedures required.

3.3 CUTTING

- A. All rectangular or special shaped openings in plaster, stucco or similar materials, including gypsum board, shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirement is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for grilles, diffusers, lighting fixtures, etc.
- B. All trades shall coordinate all openings in masonry walls with the General Contractor, and, unless otherwise indicated on the Architectural drawings, shall provide lintels for all openings required for the mechanical work (louvers, wall boxes, exhaust fans, etc.). Lintels shall be sized as follows:
 - 1. New openings under 48" in width: Provide one 3 1/2" x 3 1/2" x 3 1/2" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
 - 2. New openings 48" to 96" in width: Provide one 3 1/2" x 6" x 3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
 - 3. New openings over 96" in width: Consult the project structural engineer.

SLEEVING, CUTTING, PATCHING AND REPAIRING

**Carver Community Center Renovation
FOA 1201**

- C. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the engineer.
- D. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.
- E. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

3.4 PATCHING AND REPAIRING

- A. Patching and repairing made necessary by work performed under this division shall be included as part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the engineer.
- B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation or work of this Division, such items shall be repaired and/or replaced to the satisfaction of the engineer.
- C. Where the installation or removal of conduit, ducts, piping, etc. requires or creates the penetration of fire or smoked rated walls, ceilings or floors, the space around such conduit, duct, pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.
- D. Where ducts penetrate fire rated assemblies, fire dampers shall be provided with an appropriate access door.
- E. Piping passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.
- F. In finished areas unless otherwise noted, stainless steel collars shall be provided around all ducts, flues, breeching, large pipes, etc., at all wall penetrations; both sides.
- G. Where ducts, pipes, and conduits pass through exterior walls, the wall openings shall be sealed air and water tight. This shall include sealing on both sides of the wall to insure air and water does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

END OF SECTION 220510

**Carver Community Center Renovation
FOA 1201**

SECTION 220529 - SUPPORTS AND ANCHORS FOR MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe and Equipment Hangers, Supports, and Associated Anchors

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS
- D. Section 220700 - PIPING INSULATION
- E. Section 221000 - PLUMBING PIPING
- F. Section 232113 - HYDRONIC PIPING

1.3 REFERENCES

- A. ANSI/ASME B31.1 - Power Piping

1.4 SCOPE

- A. This specification shall apply for the design and fabrication of all hangers, supports, anchors and guides. Where piping design is such that exceptions to this specification are necessary, the particular system shall be identified, and the exceptions approved by Engineer prior to installation. See drawings.

1.5 STRUCTURE

- A. This section is intended to cover the structural requirements of the piping and equipment. It is not intended to imply that the building structure will support the loads imposed. The contractor shall review the structural drawings for where loads can be applied, what load can be supported and what structural reinforcing is required. Specific questions can be directed to the structural engineer.

**Carver Community Center Renovation
FOA 1201**

1.6 DESIGN

- A. All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0, and MSS Standard Practice SP-58, SP-69 and SP-89 except as supplemented or modified by the requirements of this specification.
- B. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized wherever possible.
- C. Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.
- D. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- E. Where possible, steel structural attachments shall be beam clamps. Other attachments shall be as scheduled.
- F. All rigid hangers shall provide a means of vertical adjustment after erection.
- G. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- H. Where horizontal piping movements are greater than ½ inch, or where the hanger load angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger rod to structural attachment shall be by use of Grinnell Fig. 47 and Fig. 299 or the hanger rod and structural attachments shall be offset in such manner that the rod is vertical in the hot position.
- I. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- J. Hangers shall be spaced in accordance with ANSI B31.1.0
- K. Where practical, riser piping shall be supported independently of the connected horizontal piping.
 - 1. Pipe support attachments to the riser piping shall be riser clamp lugs. Welded attachments shall be of material comparable to that of the pipe, and designed in accordance with ANSI B31.1 codes.

**Carver Community Center Renovation
FOA 1201**

- L. Supports, guides and anchors shall be so designed that excessive heat will not be transmitted to the building steel. The temperature of support parts shall be based on a temperature gradient of 100 degrees F per inch distance from the outside surface of the pipe.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Grinnell, Elcen, Mason Industries, Advanced Thermal, Fee & Mason, Piping Specialties, MIRO Industries.

2.2 SHIELDS

- A. Shield for Insulated Piping 2 Inches and Smaller: galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long at pipe support. See schedule for thickness.
- B. Shield for Insulated Piping 2 ½ Inches and Larger: Pipe covering protective saddles.
- C. Shields for Insulated Cold Water Piping 2 ½ Inches and Larger: Hard block non-conducting saddles in 90 degree segments, 12 inch minimum length, block thickness same as insulation thickness.
- D. Shields for Vertical Copper Pipe Risers: Sheet lead.

2.3 HANGER RODS

- A. Threaded one end, threaded both ends, threaded continuously.

2.4 INSERTS

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

2.5 PIPE HANGERS, SUPPORTS AND ANCHORS

A. BEAM CLAMPS

- 1. Beam clamps shall have malleable iron jaws, steel bolt or tie rod, nuts and jamb nuts.
- 2. C-clamps will not be permitted unless retainer is provided.

B. FINISH

SUPPORTS AND ANCHORS FOR MECHANICAL PIPING & EQUIPMENT 220529 - 3

**Carver Community Center Renovation
FOA 1201**

1. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 INSERTS

- A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- B. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

3.2 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping indicated in schedule on drawings.
- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place a hanger within 12 inches of each horizontal elbow.
- D. Provide hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support riser piping independently of connected horizontal piping.
- F. Support horizontal piping as follows:

Nominal Pipe Size	Single Rod Diameter	Thickness of Insulation Shield	Maximum Spacing		
			Ferrous Piping	Copper Tubing	HDPE Piping
3/4" & Under	3/8"	16 gauge	6'	5'	2.5'
1"	3/8"	16 gauge	7'	6'	3'
1 1/4"	3/8"	16 gauge	8'	8'	4'
1 1/2" & 2"	3/8"	16 gauge	9'	8'	4'
2 1/2" & 3"	1/2"	12 gauge	12'	8'	4'
4" & 5"	5/8"	12 gauge	14'	8'	4'
6"	3/4"	10 gauge	14'	8'	4'
8"	7/8"	8 gauge	14'	10'	5'

END OF SECTION 220529

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Pipe Hangers	X	X						
Supports	X	X						
Inserts		X						

**Carver Community Center Renovation
FOA 1201**

SECTION 220530 - METAL FABRICATIONS AND STRUCTURAL STEEL

PART 1 -GENERAL

1.1 DESCRIPTION

- A. Work included: Provide all miscellaneous metal and metal fabrications, complete, in place, as shown on the drawings, specified herein, or needed for a complete and proper installation and not specifically called for under other sections of these specifications.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS

1.3 QUALITY ASSURANCE

- A. Standards: Comply with standards specified herein.
- B. Qualifications of personnel: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.
- C. Welding: Perform all shop and field welding required in connection with the work of this section, adhering strictly to the current pertinent recommendations of the American Welding Society.

1.4 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials of this section before, during, and after installation and to protect the work and materials of all other trades.
- B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the owner.

**Carver Community Center Renovation
FOA 1201**

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

- A. Metal surfaces, general: For fabrication of the work of this section which will be exposed to view, use only those materials which are smooth and free from surface blemishes including pitting, seam marks, roller marks, rolled trade names, and roughness.
- B. Standards: All materials shall comply with:
 - 1. Steel plates, shapes, and bars: ASTM A36.
 - 2. Steel plates to be bent or cold formed: ASTM A283, Grade C.
 - 3. Steel tubing, hot-formed, welded, or seamless: ASTM A501.
 - 4. Steel bars and bar-size shapes: ASTM A306, Grade 65, or ASTM A36.
 - 5. Cold-finished steel bars: ASTM A108, grade as selected by the fabricator.
 - 6. Cold-rolled carbon steel sheets: ASTM A336.
 - 7. Galvanized carbon steel sheets: ASTM A526, with ASTM A525, G90 zinc coating.
 - 8. Gray iron castings: ASTM A48, Class 30.
 - 9. Nonshrink nonferrous grout: CE CRD C588.

2.2 FASTENERS

- A. General: Provide zinc-coated fasteners for exterior use and where built into exterior walls. Select fasteners for the type, grade, and class required.
- B. Standards: All fasteners shall comply with:
 - 1. Bolts and nuts: Regular hexagon-head type, ASTM A307, Grade A.
 - 2. Lag bolts: Square-head type, Fed. Spec. FF-B-561.
 - 3. Machine screws: Cadmium plated steel.
 - 4. Masonry anchorage devices: Expansion shields.

**Carver Community Center Renovation
FOA 1201**

2.3 PAINT PRIMER

- A. Standard primer: SSPC Paint System Guide No. 7.00.

2.4 FABRICATION

A. Workmanship

1. Use materials of size and thickness shown or, if not shown, of required size and thickness to produce strength and durability in the finished product.
2. Work to dimensions shown or accepted on the shop drawings, using proven details of fabrication and support.
3. Use type of materials shown or specified for the various components of the work.
4. Form exposed work true to line and level, with accurate angles and surfaces and with straight sharp edges.
5. Ease the exposed edges to a radius of approximately 1/32" unless otherwise shown.
6. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
7. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush; match and blend with adjoining surfaces.
8. Form exposed connections with hairline joints, flush and smooth.
9. Provide for anchorage of the type shown. Coordinate with supporting structure. Fabricate and space the anchoring devices to provide adequate support for intended use.
10. Cut, reinforce, drill, and tap miscellaneous metal work as indicated to receive finish hardware and similar items.

2.5 SHOP PAINTING

- A. Shop paint miscellaneous metal work, except members or portions of members to be embedded in concrete or masonry, surfaces and edges to be field welded, and galvanized surfaces, unless otherwise specified.
- B. Remove scale, rust, and other deleterious materials before applying shop coat.

**Carver Community Center Renovation
FOA 1201**

- C. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.

2.6 MISCELLANEOUS METAL FABRICATIONS

A. Rough Hardware

- 1. Provide bent or otherwise custom fabricated bolts, plates, anchors hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete and other structures.
- 2. Manufacture or fabricate items of sizes, shapes, and dimensions required.
- 3. Provide malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere furnish steel washers.

B. Loose bearing and leveling plates:

- 1. Provide loose bearing and leveling plates for steel items bearing on concrete construction, made flat, free from warps or twists, and of required thickness and bearing area.
- 2. Drill plates to receive anchor bolts and for grouting as required.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the areas and conditions under which miscellaneous metal items are to be installed, and correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Setting loose plates:

- 1. Clean concrete bearing surfaces free from bond-reducing materials, and roughen to improve bond to surfaces. Clean the bottom surface of bearing plates.
- 2. Set loose leveling and bearing plates on wedges, or other adjustable devices.
- 3. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shim; but if protruding, cut off flush

**Carver Community Center Renovation
FOA 1201**

with the edge of the bearing plate before packing with grout.

4. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
- B. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction including threaded fasteners for concrete inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- C. Cutting, fitting, and placement:
1. Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications.
 2. Set work accurately in location, alignment, and elevation, and make plumb, level, true, and free from rack, measured from established lines and levels.
 3. Provide temporary bracing or anchors in formwork for items which are to be built into concrete or similar construction.
 4. Fit exposed connections accurately together to form tight hairline joints.
 5. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations.
 6. Grind exposed joints smooth, and touch up shop paint coat. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.
- D. Field Welding: Comply with AWS code for procedures of manual shielded metal-arc welding, appearance and quality of weld made, and methods in correcting welding work.
- E. Touch up painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 0.051 mm (2.0 mils).

END OF SECTION 220530

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Metal Fabrication	X	X						

**Carver Community Center Renovation
FOA 1201**

SECTION 220553 - IDENTIFICATION OF MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. Identification of products installed under Division 21, 22 and 23 including:
 - 1. Plastic Nameplates
 - 2. Plastic Tags
 - 3. Metal Tags
 - 4. Stencils and Paint
 - 5. Plastic Pipe Markers
 - 6. Plastic Tape Pipe Markers

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS

1.3 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

1.4 SUBMITTALS

- A. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Submit product data and manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Seton

**Carver Community Center Renovation
FOA 1201**

- 2.2 Color: Unless specified otherwise, conform with ANSI/ASME A13.1.
- 2.3 Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- 2.4 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch square.
- 2.5 Metal Tags: Brass or aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- 2.6 Stencils: With clean cut symbols and letters of following size:

<u>Outside Diameter of Insulation or Pipe</u>	<u>Length of Color Field</u>	<u>Size of Letters</u>
3/4" - 1-1/4"	8"	1/2"
1-1/2" - 2"	8"	3/4"
2-1/2" - 6"	12"	1-1/4"
8" - 10"	24"	2-1/2"
Over 10"	32"	3-1/2"
Ductwork and Equipment	--	2-1/2"

- A. Stencil Paint: Semi-gloss enamel black unless otherwise indicated.

- 2.7 Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.
- 2.8 Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials and to accept stencil painting.

3.2 INSTALLATION

- A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.

**Carver Community Center Renovation
FOA 1201**

- B. Plastic or Metal Tags: Install with corrosive-resistant chain.
- C. Stencil Painting: Apply in accordance with manufacturer's instructions.
- D. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.
- E. Plastic Tape Pipe Markers: Install complete around pipe in accordance with manufacturer's instructions.
- F. Equipment: Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with plastic or metal tags.
- G. Controls: Identify control panels and major control components outside panels with plastic nameplates.
- H. Valves: Identify valves in main and branch piping with tags.
- I. Piping: Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Stenciled painting may be used on insulation. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.
- J. Ductwork: Identify ductwork with stenciled painting. Identify as to air handling unit number, and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 220553

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Valve Chart	X							
Valve Tags	X	X						
Stencils		X						
Tape		X						
Pipe Markers		X						

**Carver Community Center Renovation
FOA 1201**

SECTION 220600 - MECHANICAL SYSTEMS DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems and equipment.
 - 2. Training in operation and maintenance of systems, subsystems and equipment.
 - 3. Demonstration and training DVDs.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK

1.3 SUBMITTALS

- A. Instruction Program: Submit copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module
 - 1. At completion of training, submit training manual for Owner's use which includes receipts signed by the Owner acknowledging that training took place.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.
- C. Demonstration and Training DVDs: Provide recording of all demonstrations and training given and submit DVD within ten days of end of each training module.
 - 1. Identification: Provide an applied label with the following:
 - a. Name of Project
 - b. Name of Engineer
 - c. Name of Contractor

**Carver Community Center Renovation
FOA 1201**

- d. Date DVD was recorded
 - e. Description of information recorded.
2. Transcript: Prepared on 8-1/2-by 11-inch paper, punched and bound in heavy-duty, three ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding DVD. Include name of Project and date of DVD on each page.

1.4 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with operation and maintenance manual information.

PART 2 - PRODUCTS

2.1 DEMONSTRATION AND TRAINING PROGRAM

- A. Provide program that includes individual training modules for each system and equipment not a part of a system as required by individual Specification Sections and as follows, but not limited to,:
 - 1. Plumbing: Provide demonstration and training by showing Owner personnel the major components of the plumbing system as follows:
 - a. Gas piping to new HVAC equipment
 - 2. HVAC: Provide demonstration and training by showing Owner personnel the major components of the HVAC system as follows:
 - a. Variable Refrigerant Volume (VRV0 system components
 - b. Make-up Air Units and location of each
 - c. Rooftop Units and location of each
 - d. Air Filter replacement instructions
 - e. Instrumentation and Controls overview

PART 3 - EXECUTION

3.1 PREPARATION

**Carver Community Center Renovation
FOA 1201**

- A. Assemble materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

3.2 INSTRUCTION

- A. Engage qualified instructors to instruct Owner personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 - 1. Schedule training with Owner, through Architect/Engineer, with at least ten days' advance notice.

3.3 DEMONSTRATION AND TRAINING DVDS

- A. Engage a qualified individual to record demonstration and training DVDs. Record each training module separately. Include classroom instructions and demonstrations.
- B. DVD Format: Provide high-quality DVD in full-size cassettes.
- C. Narration: Describe scenes on DVD as DVD is recorded. Include description of items being viewed.
- D. Transcript: Provide typewritten transcript of the narration.

END OF SECTION 220600

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Instruction Program	X							
Attendance Record	X							
Demonstration and Training DVDs	X							

**Carver Community Center Renovation
FOA 1201**

SECTION 220700 - PIPING INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Piping Insulation
- B. Jackets and Accessories

1.2 RELATED WORK

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS
- D. Section 220553 - IDENTIFICATION OF MECHANICAL PIPING AND EQUIPMENT

1.3 QUALITY ASSURANCE

- A. Materials: Flame spread smoke developed rating of 25/50 in accordance with ASTM E84.
- B. All pipe insulation shall be installed by mechanics specializing in this type of work. The finished product shall present a neat and workmanlike appearance. Insulation shall not be applied until all tests except operating tests have been completed, all foreign material, such as rust, scale, or dirt, has been removed and the surfaces are clean and dry. Insulation shall be clean and dry when installed and during the application of any finish.
- C. The insulation, insulating materials and related items shall be delivered to the jobsite in the manufacturer's unopened containers. The containers shall have labels stating the manufacturer's name, contents, quantity and other pertinent data.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type A glass fiber insulation; ANSI/ASTM C547; 'k' value of 0.24 at 75 degrees F;

**Carver Community Center Renovation
FOA 1201**

noncombustible.

- B. Type B cellular foam; flexible, plastic; 'k' value of 0.27 at 75 degrees F; ASTM C534. APArmaflex W (white) or APArmaflex SS (black) or equal.

2.2 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.
- B. PVC Jackets: One piece, premolded type.
- C. Canvas Jackets: UL listed treated cotton fabric, 6 oz/sq yd.

2.3 ACCESSORIES

- A. Insulation Bands: 3/4 inch wide; 0.015 inch thick galvanized steel, stainless steel. 0.007 inch 0.18 thick aluminum.
- B. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum. 0.010 inch thick stainless steel.
- C. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool.
- D. Finishing Cement: ASTM C449.
- E. Fibrous Glass Cloth: Untreated; 9 oz/sq yd weight.
- F. Adhesives: Compatible with insulation.
- G. Treated wooden blocks.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install materials after piping has been tested and approved.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Continue insulation with vapor barrier through penetrations, except on fire rated walls.
- C. In exposed piping, locate insulation and cover seams in least visible locations.

PIPING INSULATION

**Carver Community Center Renovation
FOA 1201**

- D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. Provide an insert, not less than 6 inches long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2 inches diameter or larger, to prevent insulation from sagging at support points. Inserts shall be cork or other heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used. Insert shall extend around bottom 120 degrees of pipe barrel and shall be included inside vapor barrier jacket where applied. See Section 220529 for shields and hangers.
- F. Neatly finish insulation at supports, protrusions, and interruptions.
- G. Jackets
 - 1. Indoor, Concealed Applications: Insulated pipes shall have standard jackets, with vapor barrier, factory-applied or field-applied. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass cloth and adhesive. PVC jackets may be used.
 - 2. Indoor, Exposed Applications: For pipe exposed in mechanical equipment rooms or in finished spaces, insulate as for concealed applications. Finish with canvas jacket; size for finish painting. Do not use PVC jackets.
 - 3. Flanges, Valves, Anchors and Fittings: Unless otherwise specified, all flanges, valves, anchors and fittings shall be insulated with factory premolded or field fabricated segments of insulation of the same materials and thickness as the adjoining pipe insulation. When segments of insulation are used, elbows shall be provided with not less than three segments. For other fittings and valves, segments shall be cut to required curvatures, or nesting size sectional insulation shall be used. The segments of the insulation shall be properly placed and jointed with fire-resistant adhesive. After the insulation segments are firmly in place, fire-resistant vapor barrier coating shall be applied over the insulation in two coats with glass tape embedded between coats. The coating shall be applied to a total dry film thickness of 1/16 inch minimum. All glass tape seams shall be terminated neatly at the ends of the unions with insulating cement troweled on the bevel. For piping operating below ambient temperature, the beveled ends shall receive a coat of vapor barrier coating. Where anchors are used and secured directly to low temperature piping, they shall be insulated for a distance to prevent condensation, but not less than 6 inches from the surface of the pipe insulation. For jacket facing to receive finish painting, the factory applied jacket shall be as specified herein, except that the kraft paper shall be light colored with the kraft paper exposed. Field applied vapor barrier jacket shall conform to the above conditions where finish painting is required.

**Carver Community Center Renovation
FOA 1201**

<u>Piping</u>	<u>Type</u>	<u>Pipe Size (inch)</u>	<u>Thickness (inch)</u>
Refrigerant Piping	B	all	½
Condensate Drain Piping	B	all	½

Refrigerant Piping Insulation: Armstrong Armaflex insulation ½" thick with fittings covered with mitered sections of insulation and sealed with 520 adhesive. All insulation on outdoor installation shall be additionally protected with two (2) coats of Armaflex vinyl-lacquer type finish.

END OF SECTION 220700

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

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Pipe Insulation	X	X					X	
Fitting Insulation	X	X						
Insulation Block Inserts		X					X	

**Carver Community Center Renovation
FOA 1201**

SECTION 221000 - PLUMBING PIPING AND VALVES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe and Pipe Fittings
- B. Valves
- C. Gas Piping

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS
- D. Section 220553 - IDENTIFICATION FOR MECHANICAL PIPING AND EQUIPMENT

1.3 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME Code.
- C. Welders Certification: In accordance with ANSI/ASME Section 9.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING, EXTERIOR

- A. Steel Pipe: ASTM: ASTM A53 or A120, Schedule 40 black. Fittings: ASTM A234, forged steel welding type, with ANSI/AWWA C105 polyethylene tape. Joints: ANSI/AWS D1.1, welded.

2.2 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 black. Fittings: ANSI/ASME B16.3,

**Carver Community Center Renovation
FOA 1201**

malleable iron, or ASTM A234, forged steel welding type. Joints: Screwed for pipe two inches and under; ANSI/AWS D1.1, welded, for pipe over two inches. All pipe joints below slab and in concealed spaces shall be welded.

2.3 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size 2 Inches and Under: 150 psig, malleable iron unions for threaded ferrous piping; Schedule 40 250 psig malleable iron unions for threaded ferrous piping, Schedule 80 malleable unions for copper pipe, soldered joints.
- B. Pipe Size Over 2 Inches: 150 and 300 psig as required by equipment , forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; neoprene gaskets for gas service; 1/16 inch thick preformed neoprene bonded to asbestos.
- C. Grooved and Shouldered Pipe End Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; "C" shape composition sealing gasket; steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- E.

2.21 GAS COCKS

- A. Up to 2 Inches: Bronze body, bronze tapered plug, non-lubricated, teflon packing, threaded ends.
- B. Over 2 Inches: Cast iron body and plug, non-lubricated, teflon packing, flanged ends.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- B. Route piping in orderly manner and maintain gradient.
- C. Install piping to conserve building space and not interfere with use of space. Do not

**Carver Community Center Renovation
FOA 1201**

change the designed path of piping, add excessive turns or offsets, or change pipe sizes without first consulting the Engineer.

- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance for installation of insulation and access to valves and fittings.
- G. Provide access where valves and fittings are not exposed.
- H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- I. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.
- J. Install valves with stems upright or horizontal, not inverted.

3.3 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.

3.4 PAINTING OF GAS PIPING

- A. Comply with the requirements in painting specification sections for painting interior and exterior natural gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System:
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior enamel.
 - d. Color: By Owner.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System:

**Carver Community Center Renovation
FOA 1201**

- a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex.
 - d. Color: By Owner.
2. Alkyd System:
- a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd enamel matching topcoat.
 - c. Topcoat: Interior alkyd.
 - d. Color: By Owner.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

END OF SECTION 221000

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

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Gas Piping	X	X						

**Carver Community Center Renovation
FOA 1201**

SECTION 230548 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification includes vibration isolation, equipment balancing requirements and sound level criteria for equipment spaces and exterior mounted equipment.
- B. Mechanical and electrical equipment and associated piping and ductwork shall be mounted on vibration isolators as specified and/or required to minimize transmission of vibration and structure-borne noise to building structure or spaces.
- C. All rotating equipment shall be balanced both statically and dynamically. The equipment when mounted and placed in operation shall not exceed a self-excited vibration velocity of 0.10 inches per second in the vertical, horizontal or axial directions when measured with a vibration meter on the bearing caps or at the equipment mounting feet if the bearings are concealed.
- D. All electrical motors shall comply with the balancing requirements of NEMA Standard HG-1-4.23.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS

1.3 SHOP DRAWINGS

- A. Shop drawings shall be submitted as required in Section 230100: GENERAL PROVISIONS FOR MECHANICAL WORK. See Submittal Sheet.
- B. Shop drawings for neoprene mounts, or pads and spring isolators with neoprene components shall contain a certification that the neoprene compound complies with the industry standards for physical properties.
- C. All steel frames, steel bases and rails and vibration isolation units except those installed as part of the packaged equipment prior to shipment shall be furnished by one vibration isolation manufacturer.

- D. All submittals for equipment bases and equipment and piping isolation shall be in one brochure. The isolation units including steel base for each piece of equipment and connected piping shall be grouped together. Each isolation unit in the group shall show the equipment location, weight supported, type unit specified and type unit selected. Data for each spring isolator shall include outside diameter, deflection, operating spring height, solid spring height and the ratio of outside diameter to the operating height. Submittal shall include detail drawings, cut sheets and catalog data showing foundations, bases and isolators for all equipment. Certifications required for isolation materials shall be placed on all submittal drawings and catalog sheets containing neoprene items. The sound power levels in Db with reference to 10 - 12 watts, in the nine frequency bands between 31 and 8000 Hertz, exterior to the equipment as it effects the equipment space sound level shall be included with the data submitted for approval of the equipment. The sound power levels of the equipment with the resultant sound pressure levels for a room acoustics factor of 0.15 shall be plotted on an octave band analysis chart containing the broad band and pure tone Db sound pressure levels specified. When the equipment sound levels exceed the specification levels in any of the frequencies, the submittal shall include the sound attenuating enclosure or other method proposed to reduce the equipment sound level to that specified, with supporting data.
- E. The submittals for equipment mounted at the exterior of the building, or generating outside noise, shall include sound level calculations showing equipment sound level limitations based on the requirements hereinbefore specified and applicable sound level ordinances. The equipment sound pressure levels in all nine frequency bands between 31 and 8000 Hertz shall be included in the data. Where required to comply with the sound level limitations, the sound attenuation method proposed, with supporting data, shall be included with the equipment submittal.

1.4 EQUIPMENT SOUND ATTENUATION

- A. The sound pressure levels in occupied spaces generated by any mechanical and electrical equipment as transmitted by the building structure, supply or return duct borne, duct breakout or airborne through mechanical room wall and ceiling shall not exceed the following:

Octave Band Hertz							
Mid Frequency	63	125	250	500	1000	2000	4000
Sound Pressure Level dB	57	48	41	35	31	29	28

- B. The maximum allowable sound pressure levels shall be reduced by 5 Db in any octave band where field tests indicate pure tone generation.
- C. When equipment sound levels exceed the specified noise criteria removable

**Carver Community Center Renovation
FOA 1201**

acoustical enclosures, alterations to the equipment, or other approved means shall be provided to reduce the noise level to that specified. Ventilation openings in enclosures shall be provided with sound traps, access openings, observation ports and lights shall be provided where required for normal operation, observation and servicing.

- D. Equipment sound power levels may be obtained by laboratory tests measured in accordance with ASHRAE Standard No. 35-36 or by field testing. All equipment sound power tests shall be certified for compliance with the specified test procedure and accuracy by the test personnel and a responsible official of the test company.
- E. Mechanical equipment installed within or outside the building shall comply with all local, city, state and OSHA sound level requirements.
- F. Test instruments shall be calibrated for accuracy by an approved testing laboratory or by the manufacturer. Certificates showing degree of accuracy shall be furnished to the Engineer.
- G. All labor, instruments and appliances required for the tests shall be furnished by the Contractor.

1.5 VIBRATION

- A. Isolation system shall be stable during starting and stopping of equipment without excessive transverse or eccentric movement.
- B. The installed vibration isolation system shall have a maximum lateral motion under start-up and shut-down conditions of 0.25 inch. Motions in excess shall be restrained by approved spring type mountings.
- C. All electrical and piping connections shall be sufficiently flexible to permit proper isolation.
- D. Isolation components shall be selected for the lowest operating speed of the equipment.
- E. Isolators, including springs, exposed to weather shall be hot dip galvanized after fabrication.
- F. Isolators shall be selected and located to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- G. The type of isolation, base and minimum deflection shall be as required for each specific application when supported on a solid concrete slab, 6 inches total thick minimum. Vibration isolators with a deflection greater than the minimum specified shall be submitted for approval if they are needed to meet the noise criteria.

**Carver Community Center Renovation
FOA 1201**

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Mason Industries, Amber/Booth Company, Vibration Elimination Co., Inc.

2.2 ELASTOMERIC ISOLATORS

- A. Elastomeric isolators shall be one of the following:
 - 1. Neoprene isolation mounts of the straight line deflection curve type. The isolation mounts shall be manufactured with bolt holes for bolting to equipment base. Bottom steel plates for mounting to subbase shall be provided where required to prevent movement of equipment. These isolators shall be molded in black oil-resistant neoprene and color coded. All metal parts shall be embedded in neoprene.
 - 2. Neoprene pads shall be of cross-ribbed or waffle design, 5/16 inch minimum thickness. Where concentrated load bearing is encountered, steel bearing plates shall be bonded to the neoprene pads. The neoprene pads shall be sized for a load of 50 psi.

2.3 SPRING ISOLATORS

- A. Spring isolators shall be free-standing, laterally stable without any housing and complete with 1/4 inch thick neoprene acoustical friction pads between the base plate and the support.
- B. All mountings shall have leveling bolts. Coil outside diameters shall be not less than 0.8 of the operating height.
- C. Spring shall have an additional travel to solid equal to 50% of the operating deflection.
- D. The horizontal stiffness of spring isolators shall be not less than 0.8 of the vertical (axial) stiffness.
- E. Springs shall be designed and installed so that the ends remain parallel during and after deflection to operating height.

2.4 SUSPENSION TYPE ISOLATION

- A. Suspension type spring isolation for piping system or equipment hangers shall be a combination of spring and neoprene in series. The spring and elastomer combination shall be encased in a structurally stable steel bracket. Spring diameters shall be large

**Carver Community Center Renovation
FOA 1201**

enough to permit a 15 degree angular misalignment of the rod without rubbing on the hanger box.

- B. Suspension type elastomeric isolators shall be double deflection. Isolators shall be mounted in an open steel bracket with openings for hanger rod connections. The hanger rod shall be separated from contact with the hanger bracket by a neoprene grommet. The neoprene isolator shall have a minimum deflection of 0.35 inch.
- C. Where required, pipe hangers shall be equipped with a method of holding the piping at a fixed elevation during installation and a secondary adjustment to transfer the load to the spring and maintain the same elevation. Deflection shall be clearly indicated by a permanent pointer and scale.
- D. Duct isolation hangers shall consist of spring and neoprene grommet or mount encased in a steel bracket with suitable means of connecting to ducts and building structure.

2.5 FOUNDATIONS FOR MACHINERY

- A. Subbases of 3500 PSI concrete not less than 3.5 inches high shall be provided for all floor and ground mounted mechanical equipment. Subbases shall rest on structural floor and shall be reinforced with steel rods and interconnected with floor reinforcing bars by tie bars hooked at both ends or suitable dowels. A minimum clearance of 1 percent of the maximum base dimension or 1 inch shall be provided between subbases and all steel bases and steel saddles with equipment in operation.
- B. Each electric motor shall be mounted on the same foundation as the driven machine.
- C. Foundations for machines shall be a minimum of 2500 psi concrete with all exposed surfaces, steel troweled smooth and corners beveled.
- D. Machines shall be secured to steel bases with anchor bolts of ample size. All machines having baseplates shall be grouted under the full area of the baseplate with a nonshrinking, premixed grout.

PART 3 - EXECUTION

- 3.1 Provide equipment and piping vibration isolation where required by equipment manufacturer and where called for on drawings.
- 3.2 Type of vibration isolators to be provided shall be based as follows:
 - A. Static deflection up to 1/4 inch - single deflection neoprene mounting or pads.
 - B. Static deflection 5/16 inch to 3/8 inch - double deflection neoprene mountings.

VIBRATION ISOLATION

**Carver Community Center Renovation
FOA 1201**

- C. Static deflection above 3/8 inch - spring isolators.
- 3.3 Furnish vibration isolation for all piping connected to equipment mounted on vibration isolation. Equipment that has internally isolated units (compressors, etc.) shall be considered separately as to isolation requirements.

END OF SECTION 230548

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Elastomeric Isolators	X	X	X					
Suspension Type Isolators	X	X	X					
Spring Isolators	X	X	X					

SECTION 230593 - TEST, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL SPECIFICATIONS

1.1 DESCRIPTION OF WORK

- A. The total system balance shall be performed by an independent test and balance firm that specializes in testing and balancing of HVAC systems.
- B. This specialty firm shall perform the following:
 - 1. On-going job site inspections of equipment, controls and metering devices during construction to verify conformance with design specifications.
 - 2. Air System Balance
 - a. Outside Air Systems
 - b. Supply Air Systems
 - c. Return Air System
 - 3. Control Systems Verification

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.

1.3 DEFINITIONS

- A. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
- B. HVAC: Heating, Ventilating and Air Conditioning.
- C. NAS: National Account Services. An enhanced program of testing and balancing offering an expanded range of services including a Quality Assurance Guaranty.
- D. TAB: Testing, Adjusting and Balancing of HVAC systems to meet design objectives and obtain optimum system performance.
- E. TBE: Test and Balance Engineer is an individual certified by AABC or NEBB as having a degree in engineering and 3 years of test and balance experience, or, 5 years of background in the air conditioning field and 5 years continuous field experience

**Carver Community Center Renovation
FOA 1201**

in testing and balancing work.

1.4 REFERENCES

- A. 2007 ASHRAE Handbook, HVAC Applications, Chapter 37, Testing, Adjusting and Balancing.

1.5 AGENCY QUALIFICATIONS

- A. Testing and Balancing (TAB) Agency shall be a member of the AABC or NEBB.
- B. A certified Test-and-Balance Engineer (TBE) shall be responsible for certification of the total work of this section.
- C. All work shall be performed in accordance with AABC National Standards. If these specifications set forth more stringent requirements than the AABC National Standards, these specifications shall prevail.

1.6 QUALIFICATION SUBMITTALS

- A. Testing and Balancing (TAB) Agency shall submit a company resume listing personnel and project experience in the field of air and hydronic system balancing.
- B. TAB Agency shall furnish all necessary calibrated instrumentation to adequately perform the specified products. TAB Agency shall submit an inventory and calibration data of all instruments and devices in possession of the balancing agency, to enable the Owner, or his representative, to evaluate the balancing agency's performance capability.
- C. The TAB Agency shall, upon acceptance of the contract, submit to the Owner, or the Owner's representative, a "Quality Assurance Guaranty".
- D. Within 30 days after acceptance of the contract, the TAB Agency shall submit to the Design Engineer a working agenda which will include procedures for testing and balancing each type of air and water flow system. The Test and Balance Report format will also be submitted indicating data to be recorded.

1.7 NOTIFICATION AND SCHEDULING

- A. A pre-balance conference shall be held prior to job start as scheduled by the Tab Agency. Attendees at the meeting shall include representatives of the Test and Balance (TAB) Agency, General Contractor, Mechanical Sub Contractor, Control Sub Contractor, Owner and Mechanical Engineer.
- B. The schedule for testing and balancing the HVAC system shall be established by the General Contractor, and/or Owner's representative, in coordination with the TAB

**Carver Community Center Renovation
FOA 1201**

Agency on a critical path network.

- C. The TAB Agency is responsible for initiating this continuing coordinating to determine schedule for final testing and balancing services.
- D. It will be necessary for the TAB Agency to perform its services in close coordination with the Mechanical Contractor, with all scheduling and deficiencies reported through the General Contractor, and/or Owner's representative.
- E. Before testing and balancing commences, the TAB Agency shall receive notification in writing from the Mechanical Contractor that the system is operational, complete and ready for balancing.
- F. A completed system means more than just physical installation. The Mechanical Contractor shall certify that all prime movers; fans, pumps, refrigeration machines, boilers, etc., are installed in good working order, and that full load performance has been preliminarily tested.
- G. The Mechanical Contractor shall certify in writing that all equipment has been checked, started and adjusted by the manufacturer and operated for the specified period of time.

1.8 COORDINATION WITH OTHER TRADES

- A. To bring the HVAC system into a state or readiness for testing adjusting and balancing, the Mechanical Contractor shall perform the following:
 - 1. Air Distribution Systems
 - a. Ensure that all splitters, extractors, volume, smoke and fire dampers are properly located and functional. Dampers serving requirements of smoke, minimum and maximum outside, return, relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.
 - b. Verify that all supply, return, exhaust, and transfer grilles, registers, diffusers, and high pressure terminal units are installed and operational.
 - c. Ensure that air handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc. are blanked and/or sealed to eliminate excessive bypass or leakage of air.
 - d. Ensure that all fans (supply, return, relief, and exhaust) are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper

**Carver Community Center Renovation
FOA 1201**

size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating.

- e. Make any necessary changes to the sheaves, belts, and dampers, as required by the TAB Agency, at no additional cost to Owner.
- f. Install clean filters prior to testing.

B. The Temperature Control Subcontractor Shall Perform the Following:

- 1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, and fire and freeze stats.
- 2. Verify that all controlling instruments are calibrated and set for design operating conditions.
- 3. Calibrate room thermostats after installation and before the thermostat control verification tests are performed. The Test and Balance (TAB) Agency shall verify the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.
- 4. The Control Contractor shall allow sufficient time in the project to provide assistance and instruction to the TAB Agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.

C. The General Contractor and/or Owner's representative, Mechanical Contractor, Temperature Control Subcontractor, and the suppliers of the HVAC equipment shall all cooperate with the TAB Agency to provide all necessary data on the design and proper application of the system components. In addition, they shall furnish all labor and materials required to eliminate any system deficiencies.

D. In coordination with the General Contractor and/or Owner's representative, the TAB Agency shall arrange for an area of ample size and convenient location for storage of tools, equipment, and other items as required.

PART 2 - PRODUCTS - (Not applicable)

PART 3 - EXECUTION

3.1 ON-GOING JOB SITE INSPECTIONS

A. During construction, the balancing agency shall inspect the installation of pipe

SYSTEMS BALANCING

**Carver Community Center Renovation
FOA 1201**

systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of 3 times. (Typically this is performed when 60% of the duct work is installed and again when 90% of the total system is installed and prior to insulation of the piping.)

- B. The balancing agency shall submit a written report of each inspection to the Owner or owner's representative, and the contractors responsible for correcting noted deficiencies.
- C. Check for necessary balancing hardware (dampers, flow meters, valves, pressure taps, thermometer wells, etc.) to determine if they are installed properly and readily accessible.
- D. Identify and evaluate any variations from system design.
- E. Identify and report possible restrictions in systems (closed fire dampers, long runs of flexible duct, poorly designed duct fittings, etc.).

3.2 AIR SYSTEM TEST AND BALANCE PROCEDURES

- A. Fan Speeds: Test and adjust fan RPM to achieve design CFM requirements.
- B. Current and Voltage: Measure and record motor current and voltage.
- C. Pitot Tube Traverse: Perform a Pitot tube traverse of main supply and return ducts to obtain total CFM. If a Pitot tube traverse is not practical, the summation of the outlets or inlets may be used. An explanation of why a traverse was not made must appear on the appropriate data sheet.
- D. Outside Air: Test and adjust system minimum outside air by Pitot tube traverse. If a Pitot tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperature. Make allowances for heat of compression and motor heat where applicable.
- E. Static Pressure: Test and record system static pressures, including suction and discharge static pressure profile of each fan.
- F. Air Temperature: Take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry bulb temperatures shall be taken on the entering and leaving side of each heating coil.
- G. Zone Ducts (supply and return): Adjust zone ducts to within design CFM requirements. At least one zone balancing damper shall be completely open.
- H. Main Ducts: Adjust main ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

**Carver Community Center Renovation
FOA 1201**

- I. Branch Ducts: Adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
- J. Tolerance - test and balance each diffuser, grille, and register to within 10 percent of design requirement.
- K. Identification: Identify the location and area of each grille, diffuser, register, and terminal box. This information shall be recorded on air outlet data sheets.
- L. Description: Record the size and type of each diffuser, grille, and register on air outlet data sheets.
- M. Minimizing Drafts: Adjust all diffusers, grilles, and registers to minimize drafts in all areas.
- N. Exhaust Fans: Measure exhaust fan static pressure, total CFM, makeup air and fan RPM. Measure motor operating voltage and amperage.
 - 1. Measure exhaust fan static pressures, total CFM, makeup air and fan RPM.
 - 2. Measure motor operating voltage and amperage.
 - 3. Record the specified against the actual supplied horsepower and electrical characteristics of all motors.

3.3 CONTROL SYSTEMS VERIFICATION

- A. Verify that all control devices are properly connected.
- B. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
- C. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).
- D. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units.
- E. Check that all valves are properly installed in the piping system in relation to direction of flow and location.
- F. Check the calibration of all controllers..
- G. Check the location of all thermostats and humidistats for potential erratic operation

SYSTEMS BALANCING

**Carver Community Center Renovation
FOA 1201**

from outside influences such as sunlight, drafts or cold walls.

- H. Check the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.
- I. Check the sequence of operation that any control mode is in accordance with approved shop drawings. Verify that only minimum simultaneous heating and cooling occurs.
- J. Verify that all controller set points meet the design intent.
- K. Check all dampers for free travel.
- L. Verify the operation of all interlock systems.
- M. Perform all system verification to assure the safety of the system and its components.

3.4 SYSTEM PERFORMANCE VERIFICATION

- A. At the time of final inspection, the Test and Balance (TAB) Agency shall recheck, in the presence of the Owner's Representative, specific and random selections of data, air quantities, and air motion recorded in the Certified Report.
- B. Points and areas for recheck shall be selected by the Owner's Representative.
- C. Measurement and test procedures shall be the same as approved for work forming basis of Certified Report.
- D. Selections for recheck, specific plus random, will not normally exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.
- E. If random tests elicit a measured flow deviation of ten percent or more from that recorded in the Certified Report listings, by ten percent or more of the selected recheck stations, the report is rejected, all systems shall be readjusted and tested, new data recorded, new Certified Report submitted, and new inspection tests made, all at no additional cost to Owner.
- F. Following system verification of the Certified Report by the Owner's Representative, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the TAB Agency, so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after system verification.
- G. Opposite Season Test

**Carver Community Center Renovation
FOA 1201**

1. The Testing and Balancing (TAB) Agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The TAB Agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

3.5 RECORD and REPORT DATA

- A. The Test and Balance Report shall be complete with logs, data and records as required herein. All logs, data and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the Testing and Balancing (TAB) Agency's certified Test and Balance Engineer.
- B. Copies of the Test and Balance Report are required and shall be submitted to the Owner, or the Owner's representative.
- C. The report shall contain the following general data in a format selected by the TAB Agency.
 1. Project number.
 2. Contract number.
 3. Project title.
 4. Project location.
 5. Project architect.
 6. Project mechanical engineer.
 7. Test and balance agency.
 8. Test and Balance Engineer.
 9. General contractor.
 10. Mechanical subcontractor.
 11. Date tests were performed.
 12. Certification.
- D. The Test and Balance Report shall be recorded on report forms conforming to the recommended forms in AABC National Standards. At a minimum, the report shall include:
 1. Preface: A general discussion of the system, any abnormalities and problems encountered.
 2. Instrumentation List: The list of instruments including type, model, manufacturer, serial number, and calibration dates.
 3. Air Handling Equipment
 - a. Manufacturer, model number, and serial number.
 - b. All design and manufacturer related data.

**Carver Community Center Renovation
FOA 1201**

- c. Total actual CFM by traverse if practical, if not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
 - d. Suction and discharge static pressure of each fan, as applicable.
 - e. Outside air and return air total CFM.
 - f. Actual operating current, voltage, and brake horsepower of each fan motor.
 - g. Final RPM of each fan.
 - h. Fan and motor sheave manufacturer, model, size, number of grooves, and center distance.
 - i. Belt size and quantity.
 - j. Static pressure controls' final operating set points.
4. Electric Heating Coil/Duct Heater
- a. Manufacturer and model number.
 - b. All design and manufacturer rated data.
 - c. Actual operating current and voltage.
 - d. Coil location and identification number.

END OF SECTION 230593

SECTION 230800
COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Owner's Project Requirements and Systems Basis of Design documentation are included by reference.
- C. Commissioning Plan and Appendices.

1.02 SUMMARY

- A. Section includes commissioning process requirements for HVAC Systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Section 010800 - General Commissioning Requirements
 - 2. Section 010801 - Functional Testing
 - 3. Division 23 sections for HVAC equipment and assemblies

1.03 SYSTEMS COMMISSIONED

- A. Meters and Gages for HVAC Piping
- B. General-Duty Valves for HVAC Piping
- C. Testing, Adjusting, and Balancing for HVAC
- D. HVAC Insulation
- E. HVAC Instrumentation and Controls
- F. Rooftop Unit
- G. Make-up Air Unit
- H. VRV System
- I. Exhaust Fans
- J. Electric Unit Heaters

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Attend Construction Phase Commissioning Conference as part of Commissioning Team.

- B. Attend commissioning progress meetings as scheduled by Commissioning Authority.
- C. Develop Pre-functional Checklists based on preliminary checklists provided by Commissioning Authority and manufacturer's equipment startup instructions.
- D. Perform equipment Pre-functional Checklists at the direction of the Commissioning Authority.
- E. Respond to all Issues Tracking Log items identified by Commissioning Team within one (1) week of notification.
- F. Review and accept Functional Testing Procedures as prepared by Commissioning Authority.
- G. Perform functional testing as directed by the Commissioning Authority.
- H. Support Owner contracted functional testing as directed by Commissioning Authority.
- I. Perform seasonal functional testing as required by test procedures.
- J. Provide HVAC systems, assemblies, equipment, and component maintenance orientation and training as described in specifications.
- K. Provide information requested by the Commissioning Authority for final commissioning documentation.

1.05 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

- A. Review submittals for commissioned equipment against the Owner's Project Requirements.
- B. Provide project-specific Pre-functional Checklists and Functional Tests for actual HVAC Systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- C. Verify a sample of systems, assemblies, equipment, and component Pre-functional Checklists executed by Contractor.
- D. Witness a sample of systems, assemblies, equipment, and component functional testing executed by Contractor
- E. Compile test data, inspection reports, and certificates in Commissioning Report.
- F. Complete a series of three Warranty Phase reviews of systems operation.

1.06 CONTROL CONTRACTOR'S RESPONSIBILITIES

- A. Due to the impact the Facility Management System has on the success of functional testing, the following supplemental requirements shall apply.
- B. Project specific responsibilities of Controls Contractor:
 - 1. Provide a written plan to the Commissioning Authority and Architect / Engineer describing process for completing checkout and start-up of Controls System.
 - 2. Refer to the specifications for controls for the scope of controls function verification the Commissioning Authority will complete after controls checkout.
 - 3. Provide resources to facilitate Functional Testing of HVAC Systems, assemblies, equipment, and components including but not limited to technicians, any necessary

unique instruments for setting terminal units or controllers, and passwords for control system interfaces.

4. Provide resources to facilitate testing, adjusting, and balancing of Work. Refer to Section 1.08 "TAB Commissioning Specialties" and Specification Section 010801 - Functional Testing.
5. Functional testing of controls shall be completed and approved prior to start of TAB work. Refer to Section 1.08 "TAB Commissioning Specialties" and Specification Section 010801 - Functional Testing.

1.07 TAB COMMISSIONING SPECIALTIES

- A. To facilitate the commissioning process the following requirements shall apply:
 1. Prior to TAB work, the Controls Contractor shall meet with TAB Contractor to coordinate capabilities and requirements of control system for use in TAB work. Verify with Commissioning Authority that controls Functional Testing has been completed and approved.
 2. Controls Contractor shall provide access to the TAB Contractor any unique instruments for setting terminal units, controllers, or other devices and instruct in their use.
 3. Controls Contractor shall provide a technician qualified to operate building controls to assist in TAB; coordinate scheduling with TAB Contractor.

1.08 COMMISSIONING SUBMITTALS

- A. Equipment submittals for commissioned systems, assemblies, equipment, and components will be reviewed by the Commissioning Authority as part of the normal submission procedure.
- B. All testing plans and schedules to be reviewed and approved by Commissioning Authority as indicated in this Section and the Commissioning Plan.
 1. Testing, Adjusting, and Balancing
 2. Building Automation System Graphical Interface
 3. Building Automation System Point-to-point Check

1.09 COMMISSIONING DOCUMENTATION

- A. Contractor shall provide the following information to the Commissioning Authority during the commissioning process for inclusion in the Commissioning Plan:
 1. Process and schedule for completing Pre-functional Checklists for HVAC Systems, assemblies, equipment, and components to be verified and tested.
 2. Pre-functional Checklists for review and approval by Commissioning Authority and Architect / Engineer.
- B. In addition to the requirements detailed in applicable Division 23 sections, the Contractor shall provide the following information, in electronic form, to the Architect / Engineer for inclusion in the Commissioning Report:
 1. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 2. Test and inspection reports and certificates.
 3. Pre-functional Checklists results.
 4. Completed Functional Test procedures.
 5. Response to corrective action documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PRE-FUNCTIONAL CHECKLISTS PREPARATION

- A. Refer to Section 010800 - General Commissioning Requirements for complete procedures and requirements.

3.02 PRE-FUNCTIONAL CHECKLISTS EXECUTION

- A. Refer to Section 010800 - General Commissioning Requirements for complete procedures and requirements.

3.03 FUNCTIONAL TEST PREPARATION

- A. Refer to Section 010801 - Functional Testing for complete procedures and requirements.

3.04 FUNCTIONAL TEST EXECUTION

- A. Refer to Section 010801 - Functional Testing for description of tasks to complete for this project.

3.05 GENERAL FUNCTIONAL TESTING REQUIREMENTS

- A. Refer to Section 010801 - Functional Testing for complete procedures and requirements.

3.06 POST ACCEPTANCE PERIOD

- A. Refer to Section 010801 - Functional Testing for complete seasonal or deferred testing procedures and requirements.

END OF SECTION 230800

**Carver Community Center Renovation
FOA 1201**

SECTION 230850 - MECHANICAL PREVENTIVE MAINTENANCE - (ALTERNATE #7)

PART 1 - GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

PART 2 - MECHANICAL PREVENTIVE MAINTENANCE CONTRACT

2.1 LENGTH OF CONTRACT

- A. In addition to all other work indicated and specified, the Contractor shall provide the necessary skills and labor to assure the proper operation and to provide all required current preventative maintenance for all equipment and controls provided under Division 23 for a period of three(3) years after substantial completion of the contract as defined in these specifications.

2.2 VARIABLE REFRIGERANT VOLUME (VRV) SYSTEM

- A. Provide preventive maintenance, as recommended by the manufacturer, as follows:

1. Every 3 months collect operation data on the Variable Refrigerant System. This data shall include but not limited to the following data values: Condensing unit - Target condensing pressure, actual condensing pressure, target evaporator pressure, actual condensing pressure, condensing unit power input. Each indoor unit - Space temperature, space temperature setpoint, unit liquid pipe temperature, unit suction pipe temperature, unit expansion valve position.

This data shall be collected on 5 minute intervals for a period of 4 hours. The data collected shall be sent to the VRV equipment manufacturer for analysis and the manufacturer shall give a written report of the status of the system and provide any recommended repairs to the system.

All indoor unit filters shall be inspected and any filters that require cleaning/replacing shall be reported to the building owner. All outdoor unit coils shall be inspected for debris and debris removed, the outdoor coils shall be cleaned every 6 months with a manufacturer approved cleaner.

- B. All preventive maintenance to be performed by an authorized service center.
- C. The contractor performing the PM shall provide the owner a report of what was inspected, replaced, and repaired. The contractor shall also provide the owner with any recommendations of repairs that are required.

**Carver Community Center Renovation
FOA 1201**

2.3 ROOFTOP AIR CONDITIONING UNITS AND MAKE-UP AIR UNITS

- A. Provide preventive maintenance, as recommended by the manufacturer, as follows:
 - 1. Every 3 months, the following items shall be addressed: Filters shall be inspected, and filter requiring cleaning/replacement, shall be reported to the building owner. All belts shall be inspected, any belt that is worn shall be replaced, all belts shall be tensioned to the unit manufacturers recommendations. All bearings shall be greased with manufacturers approved grease. Unit refrigerant charge shall be verified by checking the sub cooling, sub cooling shall be within the manufacturers recommendations. If the refrigerant charge is not within the manufacturers recommendations, the building owner shall be notified that there may be a refrigerant leak in the system. The outdoor coil shall be inspected for debris and debris removed, the outdoor coil shall be cleaned every 6 months with a manufacturer approved coil cleaner. Verify that all dampers operate correctly. Check and tighten all electrical connections. Perform a general visual inspection of the unit and document any issues that are identified.
- B. All preventive maintenance to be performed by an authorized service center.
- C. The contractor performing the PM shall provide the owner a report of what was inspected, replaced, and repaired. The contractor shall also provide the owner with any recommendations of repairs that are required.

END OF SECTION 230850

SECTION 230900 - INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers Instrumentation and Controls which are not supplied with the various items of equipment. See all other applicable sections of this specification.
- B. The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems as herein specified. All labor, material and software necessary to meet the functional intent of the system shall be included. Equipment and labor not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the owner.
- C. The BAS system shall be BacNet compatible and have open protocol capabilities to access any part of the control system. The BAS system shall be capable of being accessed over the Internet and shall be accessible by the Owner's existing control system. BAS system should include web-based interface to LFUCG's existing WebCTRL server.

1.2 APPROVED CONTROL SYSTEM CONTRACTORS

- A. The BAS system shall be designed, installed, commissioned and serviced by manufacturer employed, factory trained personnel. No independent distributors, mechanical contractors or any contractor that is not listed below shall be approved.
 - 1. Automated Logic
 - 2. Trane

1.3 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS

1.4 QUALITY ASSURANCE

**Carver Community Center Renovation
FOA 1201**

- A. Installer Qualifications: The installer shall have an established working relationship with the Control System Manufacturer of not less than three years and be trained and approved by the Control System Manufacturer for installation of system components required for this Project.

PART 2 - PRODUCTS

2.1 DAMPERS

- 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 parallel or opposed blade types as scheduled on drawings.
- C. Electronic 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.

**Carver Community Center Renovation
FOA 1201**

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 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not required more than 11 VA.
6. 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.
7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
8. 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.
9. Actuators shall be Underwriters Laboratories Standard 873 listed.
10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

2.2 TEMPERATURE SENSORS

- A. Temperature sensors shall be Resistance Temperature Device (RTD) or Thermistor.
- B. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5m [5 feet] in length.
- C. 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.
- D. Space temperature sensors for the variable volume refrigerant (VRV) components shall be provided by the VRV manufacturer, all other space temperature sensors shall be surface mounted and equipped with a warmer-cooler knob or slide, override switch, digital room temperature display, and communication port.
- E. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.1 C [0.2 F].

2.3 HUMIDITY SENSORS

- A. Duct and room sensors shall have a sensing range of 20% to 80% with accuracy of "5% R.H.
- B. Duct sensors shall be provided with a sampling chamber.
- C. 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].
- D. Humidity sensor's drift shall not exceed 1% of full scale per year.

2.4 STATIC PRESSURE SENSORS

- A. Sensor shall have linear output signal. Zero and span shall be field-adjustable.
- B. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
- C. 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.
- D. 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.

2.5 LOW LIMIT THERMOSTATS

- A. 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.
- B. Low limit shall be manual reset only.

2.6 RELAYS

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

**Carver Community Center Renovation
FOA 1201**

2.7 TRANSFORMERS and POWER SUPPLIES

- A. 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.
- B. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
- C. Unit shall operate between 0 C and 50 C.
- D. Unit shall be UL recognized.

2.8 CURRENT SWITCHES

- A. 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.

2.9 LOCAL CONTROL PANELS

- A. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with [hinged door], key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.
- B. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control termination=s for field connection shall be individually identified per control drawings.
- C. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.

2.10 STATUS INPUTS FOR FANS

- A. Differential pressure switches piped across the fan with adjustable pressure-differential range of 8-60 psi (55-414 kPa).

2.11 CARBON DIOXIDE SENSORS

**Carver Community Center Renovation
FOA 1201**

- A. Single units using solid state sensing suitable over temperature range of 23 to 130 degf (-5 to 55 deg C), calibrated for 0-2 percent, with continuous or averaged readings. Standard sensor range shall be 0-2000 parts per million with a 0-10 vdc analog output.

2.12 POWER MONITORS

- A. Power monitors shall be three-phase type furnished with three-phase disconnect/shorting switch assembly, UL Listed voltage transformers, and UL Listed split-core current transformers.
- B. They shall provide a selectable rate pulse output for kWh reading and a 4 to 20 mA output for kW reading. They shall operate with 5 A current inputs with a maximum error of $\pm 2.5\%$ at 0.5 power factor.
- C. Power monitor shall be provided to measure kWh usage of building.

2.13 DDC HARDWARE AND SOFTWARE

- A. The new controls system must perform the following functions from all of the new and existing central operator workstations without additional software:
 - 1. Save and restore system data bases.
 - 2. Create, modify, delete and save all system data bases.
 - 3. Create, modify, delete and save control programs.
 - 4. Create, modify, delete and save point history data.
 - 5. Create, modify, and override time schedules.
 - 6. Create, display, and modify existing system graphics.
 - 7. Create, display, and print original reports from the existing system.
- B. Portable Operator's Workstation
 - 1. Provide one operator's workstation consisting of a desktop computer workstation and monitor including all software and hardware required to operate the DDC control system.
 - 2. The desktop style computer shall at a minimum contain the speed, memory and storage capacities necessary to operate the DDC control system.
- C. Workstation Operator Interface Software
 - 1. Operator workstation interface software shall use English language point identification and industry standard PC application software. The software shall provide, as a minimum the following functionality for graphical workstations.

**Carver Community Center Renovation
FOA 1201**

- a. Graphical viewing and control of environment.
 - b. Scheduling and override of building operations.
 - c. Collection and analysis of historical data.
 - d. Definition and construction of dynamic color graphics displays.
 - e. Editing, programming, storage, downloading of controller databases.
2. The software shall be an MS Windows application, and will provide a multi-tasking type environment that allows the user to run several applications simultaneously. The mouse shall be used to quickly select and switch between multiple applications.
3. Multiple-level password access protection shall be provided to allow the user/manger to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password. The Engineer shall be provided with read only access to the system.
- a. A minimum of five levels of access shall be supported.
 - b. A minimum of 50 unique passwords, including user initials, shall be supported.
 - c. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.
 - d. The system shall automatically generate a report of log-on/log-off time and system activity for each user.
 - e. User-definable, automatic log-off timers of from 5 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.
4. Software shall allow the operator to perform commands including, but not limited to the following:
- a. Start-up or shutdown selected equipment
 - b. Adjust set points
 - c. Add/modify/delete time programming
 - d. Enable/disable process execution
 - e. Lock/unlock alarm reporting for points
 - f. Enable/disable totalization for points
 - g. Enable/disable trending for points
 - h. Override PID loop set points
 - i. Enter temporary override schedules
 - j. Define holiday schedules
 - k. Change time/date
 - l. Automatic daylight savings time adjustments
 - m. Enter/modify analog alarm limits

- n. Enter/modify analog warning limits
 - o. View limits
 - p. Enable/disable demand limiting for each meter
 - q. Enable/disable duty cycle for each load
5. Reports shall be generated and directed to either CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
- a. A general listing of all points in the network
 - b. List of all points currently in alarm
 - c. List of all points currently in override status
 - d. List of all disabled points
 - e. List of all points currently locked out
 - f. DDC controller trend overflow warning
 - g. List all weekly schedules
 - h. List of holiday programming
 - i. List of limits and deadbands
 - j. Historical point activity data by time or value change
 - k. Detailed energy usage reports
 - l. Customized reports
6. Summaries shall be provided for specific points, for a logical point group, for a user-selected group or groups or for the entire facility without restriction due to the hardware configuration of the building automation system. Under no conditions shall the operator need to specify the address of the hardware controller to obtain information.
7. The operator workstation shall provide the ability to edit points and programs on-line, in real time. Automatic support for point definition shall be provided, including analog point definition assistance.
8. SCHEDULING
- a. Provide a graphical spreadsheet-type format for simplification of time of day scheduling and overrides of building operations.
9. COLLECTION AND ANALYSIS OF HISTORICAL DATA
- a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user definable. Trend data may be stored on hard disk for future diagnostics and reporting.

**Carver Community Center Renovation
FOA 1201**

- b. Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 6 points. Provide additional functionality to allow any trended data to be transferred easily to an off the shelf spreadsheet package such as Lotus 1-2-3 or Microsoft Excel.

10. DYNAMIC COLOR GRAPHIC DISPLAYS

- a. Color graphic floor plan displays and system schematics for each piece of mechanical equipment, including heat pumps, make-up air units and exhaust fans shall be provided to optimize system performance analysis and speed alarm recognition. The primary graphic for the building will be the school building's floor plan. Color graphic floor plan displays will be generated by importing AutoCAD floor plan drawings from Engineer. Each floor plan display will provide, at minimum, the outdoor air temperature and environmental conditions in hallways, offices, and major classroom areas. Each floor plan graphic shall provide links to detailed schematics for all mechanical rooms, libraries, cafeterias, and other critical areas. Graphic linking and detail penetration shall be accomplished with the pointing device without the need for menu access for keyboard entry.
- b. The operator interface shall allow users to access the various system schematics and floor plans via the graphical penetration scheme (described above), menu selection, or text-based commands.
- c. Dynamic temperature values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions. This school shall be added to all existing Apogee Windows NT operating workstations for access by the school personnel to the system via the dial-up network.
- d. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several graphics at once.
- e. Graphics generation software shall be provided to allow the user to add, modify or delete system graphic displays.
- f. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard components. Symbol library shall include both two-and three-dimensional renderings of standard HVAC equipment.
- g. The graphic development package shall use a mouse in conjunction

with a drawing program to allow the user to perform the following:

- Define symbols
- Position and size symbols
- Define background screens
- Define connecting lines and curves
- Locate, orient and size descriptive text
- Define and display colors for all elements

D. APPLICATION SPECIFIC CONTROLLERS (ASC)

1. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through LAN Device Networks. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of ASCs as a minimum as applicable to this project:
 - a. Central System Controllers
 - b. Make Up Air Unit Controllers via BACNET interface
 - c. Rooftop Unit Controllers via BACNET interface
 - d. Variable Refrigerant Volume System Controllers via BACNET interface
2. Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
 - a. Each controller shall support its own real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in the event communication is lost and to insure protection during power outages.
 - b. Programming of central system controllers shall utilize the same language and code as used by DDC Controllers to maximize system flexibility and ease of use. Should the system controller utilize a different control language, provide a DDC Controller to meet the specified functionality.
 - c. Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.

PART 3 - EXECUTION

3.1 EXAMINATION

INSTRUMENTATION AND CONTROLS FOR HVAC

**Carver Community Center Renovation
FOA 1201**

- 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 Architect/Engineer 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 Architect/Engineer for resolution before rough-in work is started.

3.2 GENERAL WORKMANSHIP

- A. Install equipment, piping, wiring/conduit parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible 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.

3.3 WIRING

- A. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications. Where the requirements of this section differ with those in Division 26, 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.

**Carver Community Center Renovation
FOA 1201**

- 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. 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.
- M. 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.

**Carver Community Center Renovation
FOA 1201**

- N. Control wiring shall not be run in building's data cable tray.

3.4 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 building 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.
- J. Furnish and install at all thermostat and sensor locations shown on the Mechanical Drawings, 1 or 2 gang boxes as required at 48" AFF with blank stainless steel plates for field mounting of thermostats and sensors. Extend wiring in 3/4" conduit from box to a point above finished ceiling. Extension of conduit system and installation of control conductors shall be provided by the temperature control contractor.

3.5 ACTUATORS

- A. Mount and link control damper actuators per manufacturer's instructions.
- B. 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.

**Carver Community Center Renovation
FOA 1201**

- C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

3.6 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 letters on laminated plastic 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.

3.7 CONTROLLERS

- A. Provide a separate Controller (controller may be equipment manufacturer supplied accessible via BACNET interface) for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.
- B. Building 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.
- C. 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.

3.8 TRAINING AND SYSTEM EVALUATION

- A. Provide a minimum of four system hands on training sessions (quarterly), 8 hours each during the contract period for personnel designated by the Owner.
- B. The BAS operator training and instructional program will be initiated to ensure that the owner/operators are instructed and trained on the many functions of their building management system. The building owner/operator will be taught to perform the following functions by factory trained, authorized building automation service representatives. The building operators will learn how to perform daily operations including:

**Carver Community Center Renovation
FOA 1201**

1. An overview of the building management system architecture and unit level controllers.
2. System logon/logoff procedures
3. Access system using menus and graphics
4. Respond to alarms
5. Make schedule changes
6. Monitor and command objects and properties
7. How to utilize and set up trends
8. Generate and save reports
9. Verification that the specified equipment sequences of operation and building control strategies are maintained in tact

C. This program will be performed on quarterly intervals with the building operators throughout the first year of system operation.

3.9 SEQUENCES OF OPERATION

A. VARIABLE REFRIGERANT VOLUME (VRV)

1. The VRV units shall run during day (occupied) mode and be off during night (unoccupied) mode as determined by the BAS time schedule.
2. See Specification Section 238136, for controls provided by VRV system manufacturer to be accessed by BAS through BACNET interface.

B. PACKAGED 100% MAKE-UP AIR UNIT & PACKAGED ROOFTOP UNIT

1. The building automation system (BAS) shall perform the following building system level control strategies, provide the points listed on the point list and provide the specified monitoring and diagnostics. The unit manufacturer shall provide the DDC controller for the unit sequence of operation. The building automation system contractor shall provide an overlay DDC controller to perform the overall building system level strategies, diagnostics, and point monitoring.
 - a. Unoccupied Operation - When the BAS initiates the unoccupied mode the unit shall be disabled.
 - b. Occupied Operation (100% Make-up Air Unit) - When the unit is controlled to the Occupied mode, all unit functions shall be enabled. The fresh air unit shall operate under supply air dew point temperature control. The unit shall default to this mode in the event that communications with the BAS are lost.

- (1) Drying, Cooling and Heating - During the Occupied mode, the fresh air unit shall control to a set of supply air set points in order to provide comfortable ventilation air to the space. The outdoor air damper shall open upon initiation of the occupied mode and remain open until the unoccupied mode.
 - c. Occupied Operation (Rooftop Unit) - When the unit is controlled to the Occupied mode, all functions shall be enabled. The unit shall operate under room thermostats/humidistat control. Outside air to be increased from 200 cfm minimum to maximum of 800 cfm based on CO2 sensor. Exhaust fan to ramp up to track outside air introduction.
 - d. Timed Override - When a Timed Override is initiated by the user, the unit shall return to its normal occupied mode for a period of time as specified at the BAS. When the Timed Override period has ended, the unit shall automatically return to its unoccupied mode. The BAS shall monitor and store the override time for each Timed Override input for documentation of after-hours operation. The BAS shall also recognize a Timed Override function if provided.
 - e. Shutdown - The BAS Priority Control program shall be able to put the zone in either the Shutdown or Occupied mode. All units that are members of that zone shall be immediately put in the Shutdown or Occupied mode. In the Shutdown mode, the unit shall turn off as rapidly as possible with all drying, cooling and heating disabled, and the outdoor damper shall be closed.
 - f. Evaporator Coil Frost Protection - A temperature sensor on the evaporator shall be used to determine if the coil is at risk of a freezing condition. Mechanical refrigeration capacity shall be shed as necessary to prevent icing. The supply fan shall continue to run and de-ice the coil. Timers shall prevent the compressors from rapid cycling.
 - g. Emergency Stop Input - A binary input shall be provided on the unit RTM module board for installation of a field-provided switch or contacts to immediately shut down all unit functions.
2. Unit Status Report - For each unit, the BAS shall provide an operating status summary of the following information to provide the operator with critical unit operating data.
 - a. Operating mode
 - b. Active cooling/drying/heating mode
 - c. General fault alarm
 - d. Supply fan status

**Carver Community Center Renovation
FOA 1201**

- e. Exhaust fan status
- f. Energy recovery wheel status
- g. Compressor on/off status
- h. Outdoor air damper status
- i. Outdoor air temperature
- j. Outdoor air relative humidity
- k. Energy wheel building return inlet temperature
- l. Energy wheel building return inlet relative humidity
- m. Energy wheel supply discharge air temperature
- n. Energy wheel supply discharge air relative humidity
- o. Supply air temperature
- p. Supply air relative humidity
- q. Outdoor airflow in CFM (air monitor provided by unit manufacture)

3. Diagnostics - The BAS system shall be able to alarm from all sensed points from the unit and diagnostic alarms sensed by the unit controller. Alarm limits shall be designated for all sensed points. Individual unit diagnostic and alarm statuses shall include the following at each unit:

- a. Emergency stop
- b. Supply fan failure
- c. Exhaust fan failure
- d. General fault alarm
- e. Freeze stat trip
- f. Outdoor air damper failure
- g. Dirty filter

C. ELECTRIC UNIT HEATERS & CABINET HEATERS

- 1. Control with wall mounted thermostat if shown and unit mounted thermostat if not shown.

D. VENTILATION SYSTEMS LIMITS

- 1. If outside air temperature is 100F and above, or 0F and below, all make-up air units and all exhaust fans shall be shutdown and all outside air dampers closed.

3.10 POINTS LIST

A. Make-up Air Units and Rooftop A/C Units

- 1. See drawings for points list.

B. Variable Air Volume (VRV) System

INSTRUMENTATION AND CONTROLS FOR HVAC

**Carver Community Center Renovation
FOA 1201**

1. Points to include all available output points provided by the VRV system manufacturer via BACNET interface.

END OF SECTION 230900

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
BAS System	X	X	X	X	X			

**Carver Community Center Renovation
FOA 1201**

SECTION 232113 - HYDRONIC PIPING & VALVES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe and pipe fittings
- B. Valves

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS
- D. Section 220700 - PIPING INSULATION

PART 2 - PRODUCTS

2.1 EQUIPMENT DRAINS, CONDENSATE DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 galvanized.
 - 1. Fittings: Galvanized cast iron, or ANSI/ASTM B16.3 malleable iron.
 - 2. Joints: Screwed, or grooved mechanical couplings.
- B. Stainless Steel Pipe: ASTM A312, Type 304/304L, full finish annealed pipe, certified for use with Vic Press 304™ joints.
 - 1. Fittings: Precision cold drawn austenitic stainless steel, Type 304/304L, complete with synthetic rubber grade EPDM O-rings.
 - 2. Joints: Vic Press 304™.
- C. Copper Tubing: ASTM B88, Type L, M or DWV hard drawn.
 - 1. Fittings: ANSI/ASME B16.18 bronze sand castings, ANSI B16.22 wrought copper, ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder

**Carver Community Center Renovation
FOA 1201**

wrought copper.

2. Grooved joint fittings, as manufactured by Victaulic, or equal, shall be manufactured to copper tubing sizes, with grooved ends designed to accept grooved end couplings of the same manufacturer. Flaring of tube and fitting ends to IPS dimensions is not allowed.
3. Joints: ASTM B32, solder, Grade 95TA or grooved joints with EPDM gaskets.

2.2 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; 300 psig stainless steel, threaded type with Vic Press 304™ ends for stainless steel pipe; bronze unions for copper pipe, soldered joints.
- B. Pipe Size Over 2 Inches: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; 1/16 inch thick preformed neoprene bonded to asbestos.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges, couplings or unions.
- D. After completion, fill, clean, and treat systems.

3.2 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
- B. Do not use bull-headed tee fittings.
- C. Install piping to conserve building space, and not interfere with use of space and other work. Do not change the designed path of piping, add excessive turns or offsets, or change pipe sizes without first consulting the Engineer.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints,

HYDRONIC PIPING

**Carver Community Center Renovation
FOA 1201**

or connected equipment.

- F. Provide clearance for installation of insulation, and access to valves and fittings.
- G. Provide access where valves and fittings are not exposed.
- H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- J. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section Painting.

3.3 APPLICATION

- A. Install unions or grooved joint couplings downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

END OF SECTION 232113

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Pipe	X	X						
Fittings	X	X						
Valves	X	X	X					
Welders Certificate						X		

**Carver Community Center Renovation
FOA 1201**

SECTION 233113 - DUCTWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Low Pressure Ducts
- B. Insulation
- C. Duct Cleaning

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS

1.3 REFERENCES

- A. ASHRAE - Handbook 1989 Fundamentals; Chapter 32- Duct Design.
- B. ASHRAE - Handbook 1989 Equipment; Chapter 1 - Duct Construction.
- C. ASHRAE - Surface Burning Characteristics of Building Materials.
- D. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- E. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- F. IMC - International Mechanical Code - Latest Issue
- G. SMACNA - Low Pressure Duct Construction Standards.
- H. UL 181 - Factory-made Air Ducts and Connections.

1.4 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

**Carver Community Center Renovation
FOA 1201**

- B. Low Pressure: Three pressure classifications: 2 inch WG positive or negative static pressure and velocities less than 2,000 fpm; 1 inch WG positive or negative static pressure and velocities less than 2,500 fpm and 2 inch WG positive or negative static pressure and velocities less than 2,500 fpm.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. C&R Sheet Metal, Ductmate, DuctSox Corporation, Eastern Sheet Metal, Euro-Aire, Fabricair, Flex-Aire, KE Fibertec, Lindab, Nordfab, or RV money.

2.2 MATERIALS

- A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.
- B. All duct material and covering shall have a flame spread rating of 24 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84.
- C. Steel Ducts: ASTM A525 or ASTM A527 galvanized steel sheet, lock forming quality, having zinc coating of 1.25 oz. Per sq. ft. for each side in conformance with ASTM G90.
- D. Flexible Ducts: Interlocking spiral of galvanized steel, or fabric supported on helically wound spring steel wire rated to 2 inches WG positive and 1.5 inches WG negative for low pressure ducts and 15 inches positive or negative for medium high pressure ducts. Flexible ducts shall conform to UL 181. Maximum length per run shall be 48".
- E. Insulated Flexible Duct: Flexible duct wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F. Maximum length per run shall be 48".
- F. Stainless Steel Ducts: ASTM A167, Type 304.
- G. Fasteners: Rivets, bolts, or sheet metal screws.
- H. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used along or with tape, or heavy mastic.
- I. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded. Stainless steel for stainless steel duct.

2.3 INSULATION

DUCTWORK

**Carver Community Center Renovation
FOA 1201**

- A. Internal: Glass fiber; ASTM C1071, G21 and G22 with an NRC not less than .65, 1.5 lb/.cu.ft. minimum density; smooth black matted air side surface for maximum 5000 FPM air velocity.
- B. External: Flexible or rigid glass fiber; ASTM C1290 and C1136 all-service duct wrap; K value of .27 at 75 degrees F and a minimum installed R-value of R-5. Provide with foil scrim facing.
- C. Insulation material and jackets shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84.
- D. Adhesives: Waterproof fire-retardant tape.
- E. Lagging Adhesives: Fire resistive to ASTM E84, NFPA 255, UL723.
- F. Impale Anchors: Galvanized steel, 12 gage, spot welded or self-adhesive pad. No anchors shall penetrate duct walls.
- G. Joint Tape: Glass fiber cloth, open mesh.
- H. Tie Wire: Annealed steel, 16 gage.

2.4 Duct Hangers

- A. All duct hangers in direct contact with galvanized duct shall be galvanized steel.
- B. All duct hangers in direct contact with stainless steel ducts shall be stainless steel.

PART 3 - EXECUTION

3.1 LOW PRESSURE DUCTWORK

- A. Fabricate and support in complete accordance with SMACNA Low Pressure Duct Construction Standards and ASHRAE handbooks latest editions, except as indicated. Provide duct material, gages, reinforcing, and sealing for operation pressures indicated.
- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation fill.

**Carver Community Center Renovation
FOA 1201**

- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 30 degrees.
- E. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.
- F. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.
- G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

3.2 DUCTWORK INSTALLATION

- A. Provide engineered openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring and maintain vapor barrier where applicable.
- B. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- C. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- E. Space between duct and floor or masonry wall openings shall be sealed with fire rated caulk.
- F. Verify all field conditions before fabrication of ductwork to avoid installation conflicts. Notify Engineer of any conflict areas.
- G. Do not change the designed path of ductwork, add excessive turns or offsets, or change duct sizes without first consulting the Engineer.

3.3 INSULATION INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.

DUCTWORK

**Carver Community Center Renovation
FOA 1201**

B. Exterior Insulation Application

1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
2. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
3. Continue insulation with vapor barrier through penetrations.

C. Internal Application

1. Adhere insulation with adhesive for 100 percent coverage. Secure insulation with mechanical fasteners on 15 inch centers maximum on top and side of ductwork with dimension exceeding 20 inches. Seal and smooth joints. DO not use nail-type fasteners. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
2. Ductwork dimensions indicated are net inside dimensions required for air flow. Increase ductwork to allow for insulation thickness.

D. Insulation Schedule

1. Rectangular supply and return air duct within conditioned space shall not require insulation.
2. Make-up air/heat recovery ductwork insulation requirements.
 - a. Building supply and/or return air duct shall have 1 inch thick minimum internal insulation on the first 15'-0' of duct from the make-up air unit including any tees and elbows. Ductwork past this point shall not require insulation.

3.4 HANGERS

- A. Duct hangers may be directly attached to ducts. Ducts shall be hung by angles or straps as listed in the following schedule. Rods, straps or angles may be used in trapeze hangers. Hangers shall be in accordance with the following schedule, except that there shall be no less than one set of hangers for each section of ductwork. Where elbows or tees are installed for changes in direction, hangers shall be provided. No ductwork shall rest on the building structural system. No ductwork shall be supported by suspended ceiling systems. All ductwork must be independently supported from building structural system.
- B. Where trapeze hangers are used, the bottom of the duct shall be supported to angle sized as follows (for round ducts, the angle shall conform to the bottom 120 degrees

DUCTWORK

of the duct):

<u>Diameter of Duct</u>	<u>Width of Duct</u>	<u>Bottom Angle Sizes</u>
0"-32"	0"-30"	1" x 1" x 1/8"
35" and Larger	31" - 48"	1-1/2" x 1-1/2" x 1/8"

- C. All hangers shall be sufficiently across-braced to eliminate, in the opinion of the Architect, excessive sway. Wherever ductwork contains filter sections, coils, fans or other heavy equipment (excluding registers, grilles, diffusers, splitter dampers, etc.) such equipment shall be hung independently of the ductwork, with rods or angles of sizes adequate to support the load.
- D. Special Duct Hanging Conditions
 - 1. In the event ductwork interferes with suspended ceiling support hangers, provide cross members from hangers affected. These cross members shall be of reinforcing steel or furring channels and shall run under ductwork in question from which additional ceiling hangers shall be supported.

END OF SECTION 233113

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to the Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	O T H E R
Duct Work	X	X						
Insulation	X	X					X	
Hangers	X	X						

**Carver Community Center Renovation
FOA 1201**

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Volume Control Dampers
- B. Fire Dampers
- C. Backdraft Dampers
- D. Air Turning Devices
- E. Flexible Duct Connectors
- F. Duct Access Doors
- G. Duct Test Holes

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS
- D. Section 233113 - DUCTWORK

PART 2 - PRODUCTS

2.1 VOLUME CONTROL DAMPERS

- A. ACCEPTABLE MANUFACTURERS
 - 1. United Enertech, Air Balance, American Warming, Arrow, Cesco, Creative Metals, Nailor, Ruskin, Vent Products, and Whiz Air.
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.

**Carver Community Center Renovation
FOA 1201**

- C. Fabricate splitter dampers of material same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
- D. Fabricate splitter dampers to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/4 inch diameter rod in self aligning, universal joint action flanged bushing with set screw.
- E. Fabricate single blade dampers for duct sizes to 12 inch.
- F. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72 inches. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- G. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- H. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.

2.2 FIRE DAMPERS

- A. Acceptable Manufacturers
 - 1. United Enertech, Air Balance, Arrow, Cesco, Greenheck, Metalaire, Prefco, Ruskin, and Vent Products.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated. Provide static and/or dynamic type as required.
- C. Fabricate ceiling firestop flaps of galvanized steel, 22 gage frame and 16 gage flap, two layers 0.125 inch ceramic fiber on top side, and one layer on bottom side for round flaps, with locking clip.
- D. Fabricate ceiling dampers of galvanized steel, 22 gage frame, stainless steel closure spring, and light weight, heat retardant non-asbestos fabric blanket closure.
- E. Fabricate curtain type dampers of galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream.
- F. Fabricate multiple blade fire dampers with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock. Fire dampers shall have UL rating.
- G. Fusible links, UL 33, shall separate at 160 degrees F. Provide adjustable link straps

DUCTWORK ACCESSORIES

**Carver Community Center Renovation
FOA 1201**

for combination fire/balancing dampers.

2.3 BACKDRAFT DAMPERS

A. Acceptable Manufacturers

1. United Enertech, Air Balance, Arrow, Cesco, Nailor, Ruskin, and Vent Products.

B. Gravity backdraft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturers standard construction.

C. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of 16 gage galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.4 AIR TURNING DEVICES

A. Acceptable Manufacturers

1. Ductmate Industries, Duro-Dyne, Metalaire, Semco, Ward Industries.

B. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps. Provide in all square turns.

2.5 FLEXIBLE DUCT CONNECTORS

A. Acceptable Manufacturers

1. Ductmate Industries, Duro-Dyne, Vent Fabrics, Ward Industries.

B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.

C. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz per square yard, approximately 6 inches wide, crimped into metal edging strip.

2.6 DUCT ACCESS DOORS

A. Acceptable Manufacturers

1. American Warming, Cesco, Ductmate Industries, Kees, Safe Air/Dowco,

DUCTWORK ACCESSORIES

233300 - 3

Vent Fabrics

- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards and as indicated.
- C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- D. Access doors smaller than 12 inches square may be secured with sash locks.
- E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- F. Access doors with sheet metal screw fasteners are not acceptable.

2.7 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions.
- B. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Use splitter dampers where required.
- C. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- E. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated.

Carver Community Center Renovation
FOA 1201

- F. Provide duct test holes where indicated and required for testing and balancing purposes.
- G. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- H. Dynamic fire dampers must be used where heating, ventilating and air conditioning systems are designed to operate with fans on during a fire (systems less than 2000 cfm).
- I. Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

END OF SECTION 233300

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Volume Control Dampers	X	X						
Fire Dampers	X	X						
Backdraft Dampers	X	X					X	
Air Turning Devices	X	X						
Flexible Duct Connectors	X	X						
Duct Access Doors	X	X						
Duct Test Holes	X	X						

**Carver Community Center Renovation
FOA 1201**

SECTION 233713 - AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Diffusers
- B. Registers/grilles

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 233113 - DUCTWORK
- C. Section 233300 - DUCTWORK ACCESSORIES

1.3 REFERENCES

- A. ADC 1062 - Certification, Rating and Test Manual.
- B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. ARI 650 - Air Outlets and Inlets.
- E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
- F. SMACNA - Low Pressure Duct Construction Standard.

1.4 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate performance of louvers in accordance with AMCA 500.

1.5 REGULATORY REQUIREMENTS

**Carver Community Center Renovation
FOA 1201**

- A. Conform to ANSI/NFPA 90A.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer listed in schedule is for design selection only.
- B. Registers, Grilles, and Diffusers
 - 1. Anemostat, Carnes, Hart and Cooley, Krueger, Metalaire, Price, Titus, Tuttle and Bailey.

2.2 RECTANGULAR CEILING DIFFUSERS

- A. Square, stamped, multicore type diffuser to discharge air in 360 degree pattern.
- B. Provide for surface mount and inverted T-bar where shown. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabricate of steel with baked enamel finish.
- D. Provide radial opposed blades damper adjustable from diffuser face for surface mounted unit where specified.

2.3 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

- A. Fixed grilles of 1/2 x 1/2 x 1 inch louvers.
- B. Fabricate margin frame with countersunk screw mounting or lay-in frame for suspended grid ceilings as shown in schedule on drawings.
- C. Fabricate of aluminum with factory clear lacquer finish.
- D. Where scheduled provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.4 WALL SUPPLY REGISTERS/GRILLES

- A. Streamlined and individually adjustable blades, depth of which exceeds 3/4 inch with adjustable blades, vertical, horizontal face, and horizontal rear deflectors.
- B. Fabricate margin frame with countersunk screw or concealed mounting and gasket suitable for surface or duct mounting.
- C. Fabricate of steel with 20 gage minimum frames and 22 gage minimum blades, steel

AIR DISTRIBUTION DEVICES

**Carver Community Center Renovation
FOA 1201**

and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish.

- D. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.5 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Streamlined blades, fixed, non-adjustable, horizontal face.
- B. Fabricate margin frame with countersunk screw or concealed mounting.
- C. Fabricate of steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish..

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furnish and install where shown on drawings all registers, grilles and diffusers in accordance with the tabulation in the schedule on drawings.
- B. Provide accessories and modifications as indicated in schedule notes.
- C. Install items in accordance with manufacturer's instructions.
- D. Install in locations as shown on drawings. Items have been located as shown to provide maximum performance. Coordinate with architectural features and notify Architect/Engineer of any conflicts.
- E. Install diffusers to ductwork with air tight connection.
- F. Provide accessible balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register.

END OF SECTION 233713

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Registers, Grilles, Diffusers	X	X	X	X				

**Carver Community Center Renovation
FOA 1201**

SECTION 234100 PARTICULATE AIR FILTRATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. 30% efficient filters.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK

1.3 REFERENCES

- A. ANSI/UL 586 - Test Performance of High Efficiency Particulate, Air Filter Units.
- B. ANSI/UL 900 - Test Performance of Air Filter Units.
- C. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

1.4 QUALITY ASSURANCE

- A. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.
- B. Provide all filters as product of one manufacturer.
- C. Assemble filter components to form filter banks from products of one manufacturer.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 220100.
- B. Include instructions for operation, changing, and periodic cleaning.

1.6 STOCK AND EXTRA STOCK

**Carver Community Center Renovation
FOA 1201**

- A. Provide one set of 30% efficient pleated filters for all equipment utilizing filters. The contractor shall be responsible for changing the air filters once the equipment has been started until substantial completion of the entire project. During this time period, filters shall be changed every 30 days with dated specified filters. New dated filters shall be installed when the systems are balanced. One complete set of filters shall be turned over to the owner at substantial completion of the entire project as a spare set. See specific specification sections regarding equipment requiring filters

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. FARR, American Air Filter, Airguard, Tri-Dim Filter Corporation.

2.2 PLEATED AIR FILTERS

- A. Air filters shall be medium efficiency, pleated, disposable type. Each filter shall consist of a non-woven cotton and synthetic fabric media, media support grid and enclosing frame. The filter shall be listed by Underwriters' Laboratories as Class 2.
- B. Filter media shall be the non-woven cotton fabric type. The filter media shall have an average efficiency of 25-30% on ASHRAE Test Standard 52-76. It shall have an average arrestance of 90-92% in accordance with that test standard.
- C. The media support shall be a welded wire grid with an effective open area of not less than 96%.
 - 1. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull away.
 - 2. The media support grid shall be formed in such a manner that it effects a radial pleat design, allowing total use of filter media.
- D. The enclosing frame shall be constructed of a rigid, heavy-duty, high wet-strength beverage board, with diagonal support members bonded to the air entering and air exit side of each pleats, to ensure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack, thus, eliminating the possibility of air bypass.

PART 3 EXECUTION

3.1 INSTALLATION

PARTICULATE AIR FILTRATION

Carver Community Center Renovation
FOA 1201

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Do not operate fan system until filters (temporary or permanent) are in place.
Replace temporary filters used during construction.

END OF SECTION 234100

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions, Supplemental Conditions, and Division 1 Specification Sections. The following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Filters	X	X	X	X				

SECTION 237423 - ROOF TOP AIR SOURCE HEAT PUMP UNIT WITH REHEAT

PART 1- GENERAL

1.1 SECTION INCLUDES

- A. Rooftop Air Heat Pump Unit With Reheat
- B. Air Cooled Condensing Unit
- C. Unit Controls

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS
- D. See drawing for further conditions, requirements and schedules.

1.3 WARRANTY

- A. Provide one(1) year manufacturer's warranty on unit.
- B. Provide four(4) year extended coverage of refrigeration compressors.

1.4 QUALITY ASSURANCE

- A. Unit shall be certified in accordance with UL Standard 1995, Safety Standard for Heating and Cooling Equipment.
Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for
- B. Mechanical Refrigeration.
- C. Unit shall be certified in accordance with ANSI Standard Z21.47, Gas-Fired Central
Furnaces.
- D. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by
ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

**Carver Community Center Renovation
FOA 1201**

- E. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.
- F. Unit and components shall be designed, manufactured, and independently analyzed, rated, and certified to meet with the seismic compliance standards of the International Building Code, 2003 edition, Section 1621. If requested, unit shall be provided with Certificate of Compliance from an independent certifying Professional Engineer clearly indicating that the unit and components meet seismic design requirements.

1.5 EXTRA MATERIALS

- A. Provide two(2) extra sets of filters for each unit.

1.6 EQUIPMENT START-UP AND SERVICE

- B. Equipment check-test-start shall be performed by a serviceman authorized by the equipment manufacturer. A complete start-up report covering each unit with model numbers and serial numbers shall be provided to the engineer.
- C. The first year parts and on-site service shall be performed by a serviceman directly employed by the unit manufacturer. Service shall include any controls that are not provided by the temperature control contractor. Service shall not include routine oiling or filter changing.
- D. If units are used during construction for heating and cooling the building, all warranties and service agreements shall cover the equipment during this use and shall not be subtracted from the extended warranties of first year's service. Service agreements on units shall start as soon as equipment is started and shall continue until one year after substantial completion of entire project. Extended warranties shall start at the date of substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish and install rooftop air heat pump unit with reheat. Performance and specifications shall meet or exceed that shown on the equipment schedule.
- B. The unit may be a split system or packaged unit. Outdoor unit shall include: air source heat pump with associated coil, supply fan, auxiliary gas heating furnace and controls. Air cooled condensing unit shall be mounted on roof. Unit shall have single point electrical connection. If a split system is used, all disconnects, interconnecting power and control wiring and refrigerant piping shall be provided and installed by equipment supplies. See Division 24 for electrical requirements.

**Carver Community Center Renovation
FOA 1201**

Mechanical contractor shall be responsible for coordinating installation.

2.2 PRINCIPLE OF OPERATION

- A. The unit shall be designed to provide conditioned air with controlled relative humidity. Air is to be treated by filtering, removing moisture, and reducing the relative humidity level of the discharge air in summer and preheating in winter.
- B.
- C. The specification contained herein is based around the Aaon unit specified on the drawings. Other manufacturers with equipment able to meet the intent of this specification as noted in paragraph A above and as described in the control sequence below will be considered equal.

2.3 UNIT PERFORMANCE

- A. Unit cooling capacities shall be in accordance with and tested to ARI standard 210/240-89 or 360-85.
- B. Efficiencies
 - 1. Units up to 20 tons shall carry the ARI compliance label.
 - 2. Unit MINIMUM cooling efficiency, including the standard supply air blower motor shall be as shown on the plans.

MANUFACTURER

2.4

- A. Products shall be provided by the following manufacturers.
 - 1. AAON, Addison, Trane, Venmar, McQuay, Engineered Air, Valent or Semco (Pinnacle)
 - 2. Approved equal shall be acceptable if equipment includes
 - Direct drive supply blowers
 - Double wall cabinet construction
 - Insulation with an R-value of 13
 - Stainless steel drain pans

Hinged access doors with lockable handles

Modulating compressor(s) (10-100% capacity)

Air Source Heat Pump with Backup gas heat

R-410A refrigerant

GENERAL DESCRIPTION

2.5

- A. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply blowers, exhaust blowers, dampers, condenser coils, condenser fans, reheat coils, auxiliary gas heat and unit controls.
- B. Unit shall be factory assembled and tested including helium leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
- C. Unit shall have decals and tags to indicate lifting and rigging, service areas, and caution areas for safety and to assist service personnel.
- D. Unit components shall be labeled, including pipe stub outs, refrigeration system components, and electrical and controls components.
- E. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
- F. Installation, Operation, and Maintenance manual shall be supplied within the unit.
- G. Laminated color-coded wiring diagram shall match factory installed wiring and be provided in both point-to-point and ladder form and affixed to the interior of the control compartment's hinged access door.
- H. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

2.6 CONSTRUCTION

Carver Community Center Renovation
FOA 1201

- A. All cabinet walls, access doors and roof shall be fabricated of rigid, impact resistant, double wall, high performance composite panels with G90 galvanized steel on both sides and a closed cell polyurethane foam interior core.
- B. Foam shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 8 inches of positive or negative static pressure. Deflection shall be measured at the midpoint of the panel height and width.
- D. Cabinet leakage rate shall not exceed 1% when tested at 6 inches of static pressure.
- E. Insulation shall have an R-value of 13.
- F. All cabinet walls, access doors and roof shall have a thermal break with no metal path to inside to outside.
- G. Units with cooling coils shall include double sloped 304 stainless steel drain pans and a factory provided p-trap, for field installation.
- H. Roof of the air tunnel shall be sloped to provide complete drainage.
- I. Unit shall have rain break overhangs above access doors.
- J. Exterior paint finish shall be capable of withstanding at least 2500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- K. Access to filters, dampers, economizers, cooling coils, power exhaust and return blowers, controls, compressors, and heaters shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
- L. All openings through the base pan of the unit shall have upturned flanges of at least 0.5 inches in height around the opening through the base pan.

**Carver Community Center Renovation
FOA 1201**

M. Unit shall include lifting lugs on the top of the unit.

N. Entire bottom of unit (all compartments) shall be waterproofed to prevent leakage from unit into building.

2.7 **ELECTRICAL**

1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch in the unit control panel.

2. Unit shall be provided with factory installed and factory wired 115V, 13 amp GFI outlet with outlet disconnect switch in the unit control panel.

3. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.

2.8 **SUPPLY BLOWERS**

A. Unit shall include variable frequency direct drive, unhooded, backward curved, plenum supply blower(s).

B. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.

C. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

D. Variable frequency drive(s) shall be factory wired and mounted in the unit. Blower motor(s) shall be premium efficiency.

2.9 **EXHAUST BLOWERS**

A. Exhaust Dampers shall be sized for 100% relief.

B. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.

**Carver Community Center Renovation
FOA 1201**

- C. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
- D. Access to exhaust blowers shall be through double wall, hinged access door with quarter turn handles.
- E. Unit shall include belt driven, unhooded, backward curved, plenum exhaust blower(s).
 - 1. Variable frequency drive(s) shall be factory wired and mounted in the unit. Blower motor(s) shall be premium efficiency.

COOLING COILS

2.10

- A. Evaporator Coil(s)
 - 1. Coils shall be designed for use with refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
 - 2. Coils shall have interlaced circuitry and shall be 6 row high capacity.
 - 3. Coils shall be helium leak tested.
 - 4. Coil shall be furnished with a factory installed thermostatic expansion valve.

REFRIGERATION SYSTEM

2.11

- A. Unit shall be factory charged with refrigerant.
- B. Compressors shall be scroll type with thermal overload protection, independently circuited, and carry a 5 year non-prorated warranty.
- C. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, high performance composite panels with an R-value of 13 to prevent the transmission of noise outside the cabinet.

- D. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressor into the building area.
- E. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
- F. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and factory installed liquid line filter driers.
- G. Unit shall include a modulating capacity scroll compressor on the first refrigeration circuit. The unit shall be capable of modulation from 5-100% of its capacity. An on/off compressor on the first refrigerant circuit with hot gas bypass for capacity control is not acceptable.
- H. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allows the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
- I. Each refrigeration circuit shall be equipped with a liquid line sight glass.
- J. Unit shall be configured as an air source heat pump. Each refrigerant circuit shall be equipped with a factory installed liquid line filter drier with check valve, accumulator, and thermal expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump heating mode of operation.

2.12 CONDENSERS

A. Air-Cooled Condenser

- 1. Condenser fans shall be vertical discharge axial flow direct drive fans.
- 2. Coils shall be designed for use with refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled

**Carver Community Center Renovation
FOA 1201**

3. Coils shall be designed for a minimum of 10 degrees of refrigerant sub-cooling.
4. Coils shall be helium leak tested.

GAS HEATING

2.13

- A. Natural gas stainless steel furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller shall include a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment.
- B. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty.
- C. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
- D. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off pilot when heating is not required.
- E. Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.

FILTERS

2.14

- A. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 7, upstream of the cooling coil.
- B. New filters shall be installed at substantial completion in addition to the extra set of filters provided.

OUTSIDE AIR

2.15

- A. Unit shall include 100% motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Damper assembly shall be controlled by spring return, 2 position actuator. Unit shall include outside air opening bird screen and outside air hood with rain lip.

2.17 CONTROLS

- A. Controls shall be provided by the unit supplier.
- B. Unit controller to be capable of controlling all features and options of the unit. Controller shall be field installed in the unit controls compartment and field tested.
 - 1. With modulating hot gas reheat option, a field installed outside air humidity sensor and a field installed supply air temperature sensor shall be furnished to control the amount of reheat during dehumidification. Supply air setpoint temperature shall be field adjustable.
 - 2. With modulating heat option, a field supplied supply air temperature sensor shall be furnished to control the amount of heating. Supply air temperature setpoint shall be field adjustable.
 - 3. With enthalpy activated fully modulating economizer option, an outdoor air humidity sensor shall be field installed.
 - 4. Controller shall have an onboard clock and calender functions that allow for occupancy scheduling.
 - 5. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 - 6. Controller shall contain diagnostics to indicate controller power, communications, unit alarms and sensor failures.
 - 7. Controller shall be capable of stand alone operation with unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available without dependence on a building management system.
 - 8. Controller shall be provided with a BACnet gateway to allow the BMS to communicate with the unit. The gateway shall allow adjustment of all writeable points.

2.19 ROOF CURBS

Carver Community Center Renovation
FOA 1201

- A. Welded 18 gauge galvanized steel shell and base plate, 1-1/2" thick 3 pound density rigid insulation and factory installed 2x2 wood nailer. Minimum height to be 12".

PART 3 - EXECUTION

INSTALLATION, OPERATION, AND MAINTENANCE

3.1

- A. Installation, Operation, and Maintenance manual shall be supplied with the unit.
- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.
- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.
- D. Install in a manner to provide required access for maintenance and service.
- E. Mount unit on factory insulated curb providing watertight enclosure to protect ductwork and utility services. Top of curb to be a minimum height of 12" above the adjacent finished roof service.

3.2

DEMONSTRATION

- A. Provide Owner's maintenance personnel training as required to adjust , operate and maintain units.

END OF SECTION 237423

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Roof Top Make-up Air Unit	X	X	X	X	X			

SECTION 237433 - ROOF TOP MAKE-UP AIR HEAT PUMP DEHUMIDIFICATION UNIT

PART 1- GENERAL

1.1 SECTION INCLUDES

- A. Rooftop Heat Recovery/Dehumidification Unit
- B. Air Cooled Condensing Unit
- C. Unit Controls

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS
- D. See drawing for further conditions, requirements and schedules.

1.3 WARRANTY

- A. Provide one(1) year manufacturer's warranty on unit.
- B. Provide four(4) year extended coverage of refrigeration compressors.

1.4 QUALITY ASSURANCE

- A. Unit shall be certified in accordance with UL Standard 1995, Safety Standard for Heating and Cooling Equipment.
Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for
- B. Mechanical Refrigeration.
- C. Unit shall be certified in accordance with ANSI Standard Z21.47, Gas-Fired Central
Furnaces.
- D. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by
ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

**Carver Community Center Renovation
FOA 1201**

- E. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.
- F. Unit and components shall be designed, manufactured, and independently analyzed, rated, and certified to meet with the seismic compliance standards of the International Building Code, 2003 edition, Section 1621. If requested, unit shall be provided with Certificate of Compliance from an independent certifying Professional Engineer clearly indicating that the unit and components meet seismic design requirements.

1.5 EXTRA MATERIALS

- A. Provide two(2) extra sets of filters for each unit.

1.6 EQUIPMENT START-UP AND SERVICE

- B. Equipment check-test-start shall be performed by a serviceman authorized by the equipment manufacturer. A complete start-up report covering each unit with model numbers and serial numbers shall be provided to the engineer.
- C. The first year parts and on-site service shall be performed by a serviceman directly employed by the unit manufacturer. Service shall include any controls that are not provided by the temperature control contractor. Service shall not include routine oiling or filter changing.
- D. If make-up air units are used during construction for heating and cooling the building, all warranties and service agreements shall cover the equipment during this use and shall not be subtracted from the extended warranties of first year's service. Service agreements on make-up air units shall start as soon as equipment is started and shall continue until one year after substantial completion of entire project. Extended warranties shall start at the date of substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish and install outdoor air dehumidification control system. Performance and specifications shall meet or exceed that shown on the equipment schedule.
- B. The heat recovery/dehumidifier may be a split system or packaged unit. Outdoor unit shall include: heat recovery heat exchanger, unitary dehumidification coil, supply fan, exhaust fan, auxiliary gas heating furnace and controls. Air cooled condensing unit shall be mounted on roof. Unit shall have single point electrical connection. If a split system is used, all disconnects, interconnecting power and control wiring and refrigerant piping shall be provided and installed by equipment supplies. See

**Carver Community Center Renovation
FOA 1201**

Division 24 for electrical requirements. Mechanical contractor shall be responsible for coordinating installation.

2.2 PRINCIPLE OF OPERATION

- A. The unit shall be designed to treat make-up air by filtering, removing moisture, and reducing the relative humidity level of the discharge air in summer and preheating in winter. Unit shall be capable of recovering energy from exhaust airstream in both summer and winter operation.
- B. The specification contained herein is based around the Aaon unit specified on the drawings. Other manufacturers with equipment able to meet the intent of this specification as noted in paragraph A above and as described in the control sequence below will be considered equal.

2.3 UNIT PERFORMANCE

- A. Unit cooling capacities shall be in accordance with and tested to ARI standard 210/240-89 or 360-85.
- B. Efficiencies
 - 1. Units up to 20 tons shall carry the ARI compliance label.
 - 2. Unit MINIMUM cooling efficiency, including the standard supply air blower motor shall be as shown on the plans.

MANUFACTURER

2.4

- A. Products shall be provided by the following manufacturers.
 - 1. AAON, Addison, Trane, Venmar, McQuay, Engineered Air, Valent or Semco (Pinnacle)
 - 2. Approved equal shall be acceptable if equipment includes
 - Direct drive supply blowers
 - Double wall cabinet construction
 - Insulation with an R-value of 13

Stainless steel drain pans

Hinged access doors with lockable handles

Modulating compressor(s) (10-100% capacity)

Make up air capability (up to 100% outside air)

Air Source Heat Pump with Backup gas heat

R-410a refrigerant

GENERAL DESCRIPTION

2.5

- A. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply blowers, dampers, condenser coils, condenser fans, reheat coils, auxiliary gas heaters, exhaust fans, energy recovery wheel and unit controls.
- B. Unit shall be factory assembled and tested including helium leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
- C. Unit shall have decals and tags to indicate lifting and rigging, service areas, and caution areas for safety and to assist service personnel.
- D. Unit components shall be labeled, including pipe stub outs, refrigeration system components, and electrical and controls components.
- E. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
- F. Installation, Operation, and Maintenance manual shall be supplied within the unit.
- G. Laminated color-coded wiring diagram shall match factory installed wiring and be provided in both point-to-point and ladder form and affixed to the interior of the control compartment's hinged access door.

**Carver Community Center Renovation
FOA 1201**

- H. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

CONSTRUCTION

2.6

- A. All cabinet walls, access doors and roof shall be fabricated of rigid, impact resistant, double wall, high performance composite panels with G90 galvanized steel on both sides and a closed cell polyurethane foam interior core.
- B. Foam shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 8 inches of positive or negative static pressure. Deflection shall be measured at the midpoint of the panel height and width.
- D. Cabinet leakage rate shall not exceed 1% when tested at 6 inches of static pressure.
- E. Insulation shall have an R-value of 13.
- F. All cabinet walls, access doors and roof shall have a thermal break with no metal path to inside to outside.
- G. Units with cooling coils shall include double sloped 304 stainless steel drain pans and a factory provided p-trap, for field installation.
- H. Roof of the air tunnel shall be sloped to provide complete drainage.
- I. Unit shall have rain break overhangs above access doors.
- J. Exterior paint finish shall be capable of withstanding at least 2500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- K. Access to filters, dampers, economizers, cooling coils, power exhaust and return blowers, controls, compressors, and heaters shall be through hinged access doors

**Carver Community Center Renovation
FOA 1201**

with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.

L. All openings through the base pan of the unit shall have upturned flanges of at least 0.5 inches in height around the opening through the base pan.

M. Unit shall include lifting lugs on the top of the unit.

N. Entire bottom of unit (all compartments) shall be waterproofed to prevent leakage from unit into building.

ELECTRICAL

2.7

1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch in the unit control panel.

2. Unit shall be provided with factory installed and factory wired 115V, 13 amp GFI outlet with outlet disconnect switch in the unit control panel.

3. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.

SUPPLY BLOWERS

2.8

A. Unit shall include variable frequency direct drive, unhooded, backward curved, plenum supply blower(s).

B. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.

C. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

D. Variable frequency drive(s) shall be factory wired and mounted in the unit.
Blower motor(s) shall be premium efficiency.

EXHAUST BLOWERS

2.9

**Carver Community Center Renovation
FOA 1201**

- A. Exhaust Dampers shall be sized for 100% relief.
- B. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
- C. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
- D. Access to exhaust blowers shall be through double wall, hinged access door with quarter turn handles.
- E. Unit shall include belt driven, unhooded, backward curved, plenum exhaust blower(s).

COOLING COILS

2.10

- A. Evaporator Coil(s)
 - 1. Coils shall be designed for use with refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
 - 2. Coils shall have interlaced circuitry and shall be 6 row high capacity.
 - 3. Coils shall be helium leak tested.
 - 4. Coil shall be furnished with a factory installed thermostatic expansion valve.

REFRIGERATION SYSTEM

2.11

- A. Unit shall be factory charged with refrigerant.
- B. Compressors shall be scroll type with thermal overload protection, independently circuited, and carry a 5 year non-prorated warranty.
- C. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, high performance composite panels with an R-value of 13 to prevent the transmission of noise outside the cabinet.

- D. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressor into the building area.
- E. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
- F. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and factory installed liquid line filter driers.
- G. Unit shall include a modulating capacity scroll compressor on the first refrigeration circuit. The unit shall be capable of modulation from 5-100% of its capacity. An on/off compressor on the first refrigerant circuit with hot gas bypass for capacity control is not acceptable.
- H. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allows the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
- I. Each refrigeration circuit shall be equipped with a liquid line sight glass.
- J. Unit shall be configured as an air source heat pump. Each refrigerant circuit shall be equipped with a factory installed liquid line filter drier with check valve, accumulator, and thermal expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump heating mode of operation.

2.12 CONDENSERS

A. Air-Cooled Condenser

- 1. Condenser fans shall be vertical discharge axial flow direct drive fans.
- 2. Coils shall be designed for use with refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled

Carver Community Center Renovation
FOA 1201

3. Coils shall be designed for a minimum of 10 degrees of refrigerant sub-cooling.
4. Coils shall be helium leak tested.

GAS HEATING

2.13

- A. Natural gas stainless steel furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller shall include a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment.
- B. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty.
- C. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
- D. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off pilot when heating is not required.
- E. Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.

FILTERS

2.14

- A. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 7, upstream of the cooling coil.
- B. New filters shall be installed at substantial completion in addition to the extra set of filters provided.

OUTSIDE AIR

2.15

- A. Unit shall include 100% motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Damper assembly shall be controlled by spring return, 2 position actuator. Unit shall include outside air opening bird screen and outside air hood with rain lip.

2.16

ENERGY RECOVERY

- A. Unit shall contain a factory mounted and tested energy recovery wheel(s). The energy recovery wheel(s) shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.
- B. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
- C. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- D. The wheel shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
- E. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
- F. All diameter and perimeter seals shall be provided as part of the cassette assembly

Carver Community Center Renovation
FOA 1201

and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

- G. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with *ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers* and *ARI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment*. *Cassettes shall be listed in the ARI Certified Product.*
- H. Units shall include 4 inch thick, pleated panel outside air filters with an ASHRAE efficiency of 30% and MERV rating of 7, upstream of the wheel.
- I. Hinged service access door shall allow access to the wheel(s).

CONTROLS

2.17

- A. Controls shall be provided by the unit supplier.
- B. Unit controller to be capable of controlling all features and options of the unit. Controller shall be field installed in the unit controls compartment and field tested.
 - 1. With modulating hot gas reheat option, a field installed outside air humidity sensor and a field installed supply air temperature sensor shall be furnished to control the amount of reheat during dehumidification. Supply air setpoint temperature shall be field adjustable.
 - 2. With modulating heat option, a field supplied supply air temperature sensor shall be furnished to control the amount of heating. Supply air temperature setpoint shall be field adjustable.
 - 3. With enthalpy activated fully modulating economizer option, an outdoor air humidity sensor shall be field installed.
 - 4. Controller shall have an onboard clock and calender functions that allow for occupancy scheduling.
 - 5. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 - 6. Controller shall contain diagnostics to indicate controller power, communications, unit alarms and sensor failures.

**Carver Community Center Renovation
FOA 1201**

7. Controller shall be capable of stand alone operation with unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available without dependence on a building management system.
8. Controller shall be provided with a BACnet gateway to allow the BMS to communicate with the unit. The gateway shall allow adjustment of all writeable points.

2.18 CONTROL SEQUENCE

1. Provide enthalpy controller or separate thermostat and humidistat on incoming air to unit to control compressor operation and a discharge air thermostat to control reheat.
2. If the conditions require the air to be cooled, the unit controls will bring on the compressor(s) and lock out electric heat. Below 55 degrees F ambient (adjustable) the compressor will be locked out.
3. If the conditions require the air to be heated, the unit controls will activate electric heat as needed to heat the supply air to the space. These heaters will be locked out above 60 degrees F Ambient.
4. If the conditions require the air to be dehumidified, the unit controls will bring on the compressor and the heat reclaim coil. The result will be dry reheated air being discharged from the unit controlled by a discharge thermostat. If dehumidification is required with the entering air temperature below 60 degrees F ambient (adjustable) the unit controls will use electric heat to control the supply air to the space.
5. Provide humidity sensor in return air stream and temperature sensor in supply air stream. DDC system to indicate fan on, humidity high (higher than 60% adjustable), supply temperature high (higher than 80° adjustable), and supply temperature low (lower than 60° adjustable). All indicators shall be on time delay set to activate when measurement is out of range for two minutes.

2.19 ROOF CURBS

- A. Welded 18 gauge galvanized steel shell and base plate, 1-1/2" thick 3 pound density rigid insulation and factory installed 2x2 wood nailer. Minimum height to be 12".

PART 3 - EXECUTION

INSTALLATION, OPERATION, AND MAINTENANCE

3.1

- A. Installation, Operation, and Maintenance manual shall be supplied with the unit.

Carver Community Center Renovation
FOA 1201

- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.
- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.
- D. Install in a manner to provide required access for maintenance and service.
- E. Mount unit on factory insulated curb providing watertight enclosure to protect ductwork and utility services. Top of curb to be a minimum height of 12" above the adjacent finished roof service.

3.2 DEMONSTRATION

- A. Provide Owner's maintenance personnel training as required to adjust , operate and maintain units.

END OF SECTION 237433

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Roof Top Make-up Air Unit	X	X	X	X	X			

SECTION 238136 – VARIABLE REFRIGERANT VOLUME (VRV) SYSTEM

PART 1 – GENERAL

1.1 SYSTEM DESCRIPTION

- A. The variable capacity, heat recovery air conditioning system shall be a Variable Refrigerant Volume Series or equal (heat and cool model) split system as specified. The condenser shall be a direct expansion (DX), water heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant. The condensing unit may connect an indoor evaporator capacity up to 200% of the condensing unit capacity. All zones are each capable of operating separately with individual temperature control.
- B. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with each branch. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.

1.2 QUALITY ASSURANCE

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
- B. All wiring shall be in accordance with the National Electric Code (NEC).
- C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- D. Mechanical equipment for wind-born debris regions shall be designed in accordance with ASCE 7-2002 and installed to resist the wind pressures on the equipment and the supports.
- E. The condensing unit will be factory charged with R-410A.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Unit shall be stored and handled according to the manufacturer's recommendations.

**Carver Community Center Renovation
FOA 1201**

1.4 WARRANTY

- A. The units shall have a manufacturer's warranty for a period of one (1) year from date of substantial completion of the project. The system shall have a full parts and labor warranty for a period of one (1) year from date of substantial completion of the project. The compressors shall have a parts warranty of six (6) years from date of substantial completion of the project. All warranty service work shall be performed by a manufacturer's factory trained service professional.

1.5 OWNER TRAINING

- A. The manufacturer shall provide 16 hours of onsite owner training to be scheduled by the Owner. The manufacturer shall provide 2 days of training at the manufacturer's certified training center. The training shall include system diagnostics and troubleshooting and shall be a hands on training class using a working system in the training center.

1.6 INSTALLATION REQUIREMENTS

- A. The system must be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the system's installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements.

1.7 OPERATING RANGE

- A. The operating range in cooling will be (-4°F) 23°F DB ~ 122°F DB. Each system as standard shall be capable of on site reprogramming to allow low ambient cooling operation to -4°F DB.
- B. The operating range in heating will be 0°F DB – 77°F DB / -4°F WB – 60°F WB. Simultaneous cooling/heating operating range will be (-4°F) 23°F WB ~ 60°F WB.
- C. Cooling mode indoor room temperature range will be 57°F-77°F WB. Heating mode indoor room temperature range will be 59°F-80°F DB.

1.8 REFRIGERANT PIPING

- A. The system shall be capable of refrigerant piping up to 540 actual feet or 620 equivalent feet from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280 feet of piping between the condensing and indoor units with 295 feet maximum vertical difference, without any oil traps.

**Carver Community Center Renovation
FOA 1201**

1.9 DESIGN BASIS

- A. The HVAC equipment basis of design is Daikin AC. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

- B. Non-Basis of Design Manufacturers:
 - 1. Sanyo
 - 2. Mitsubishi
 - 3. LG

PART 2 – PRODUCTS

2.1 CONDENSING UNIT

- A. General: The condensing unit is designed specifically for use with VRV series components.
 - 1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.
 - 2. The connection ratio of indoor units to condensing unit shall be permitted up to 200%.
 - 3. Each condensing system shall be able to support the connection of up to 56 indoor units dependant on the model of the condensing unit.
 - 4. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
 - 5. The unit shall incorporate an auto-charging feature.

**Carver Community Center Renovation
FOA 1201**

6. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
7. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
8. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.

B. Unit Cabinet:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Compressor:

1. The inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "G2-type" with a maximum speed of 7,980 rpm.
3. The capacity control range shall be as low as 4% to 100%.
4. Each non-inverter compressor shall also be of the hermetically sealed scroll type.

**Carver Community Center Renovation
FOA 1201**

5. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
6. Oil separators shall be standard with the equipment together with an intelligent oil management system.
7. The compressor shall be spring mounted to avoid the transmission of vibration.
8. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

D. Electrical:

1. The power supply to the condensing unit shall be 208 volts, 3 phase, 60 hertz +/- 10%.

2.2 ROUND FLOW CEILING CASSETTE UNIT (3'x3')

A. General: Indoor unit shall be a round flow ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. The indoor units sound pressure shall range from 27 dB(A) to 34 dB(A) at low speed measured at 5 feet below the unit.

B. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

**Carver Community Center Renovation
FOA 1201**

3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through the concentric panel, which includes a resin net, mold resistant, antibacterial filter.
5. The indoor units shall be equipped with a condensate pan with antibacterial treatment and condensate pump. The condensate pump provides up to 33-1/2" of lift and has a built in safety shutoff and alarm.
6. The indoor units shall be equipped with a return air thermistor.
7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
8. The voltage range will be 253 volts maximum and 187 volts minimum.

C. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down outlets with multiple patterns allowing for simpler installation in irregular spaces.
4. Fresh air intake shall be possible by way of optional fresh air intake kit.
5. A branch duct knockout shall exist for branch ducting of supply air.
6. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
7. Optional high efficiency MERV 8 and 13 air filters are available for each model unit.

D. Fan:

**Carver Community Center Renovation
FOA 1201**

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with three fan speeds available.
2. The fan motor shall operate on 208 volts, 1 phase, 60 hertz with a motor output range from 0.08 to 0.16 HP.
3. The airflow rate shall be available in three settings.
4. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with the MERV 8 and 13 filter options.
5. The fan motor shall be thermally protected.

E. Filter:

1. High efficiency disposable MERV 8 and 13 filters shall be available.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
4. A condensate pan with antibacterial treatment shall be located under the coil.
5. A condensate pump with a 33-1/2 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
6. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208 volts, 1 phase, 60 hertz.

**Carver Community Center Renovation
FOA 1201**

2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. Control:

1. The unit shall have controls provided by the manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
3. Remote "in-room" sensor.
 1. The wall mounted, hard wired remote sensor kit shall be provided in all zones (branch wiring is included in the kit).

2.3 4 WAY CEILING CASSETTE UNIT (2'x2')

A. General: Indoor unit shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be available in capacities from 7,500 Btu/h to 18,000 Btu/h. It shall be a four-way air distribution type, white, impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room. The indoor units sound pressure shall range from 29 dB(A) to 34 dB(A) at low speed measured at 5 feet below the unit.

B. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate

**Carver Community Center Renovation
FOA 1201**

safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
6. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift and has a built in safety shutoff and alarm.
7. The indoor units shall be equipped with a return air thermistor.
8. All electrical components are reached through the decoration panel, which reduces the required side service access.
9. The indoor unit will be separately powered with 208V/1-phase/60Hz.
10. The voltage range will be 253 volts maximum and 187 volts minimum.

C. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.

**Carver Community Center Renovation
FOA 1201**

5. A branch duct knockout shall exist for branch ducting supply air.
 6. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
- D. Fan:
1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
 2. The fan motor shall operate on 208 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
 3. The airflow rate shall be available in high and low settings.
 4. The fan motor shall be thermally protected.
- E. Filter:
1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
- F. Coil:
1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
 4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.
 5. A condensate pan shall be located under the coil.
 6. A condensate pump with a 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.

**Carver Community Center Renovation
FOA 1201**

7. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. Control:

1. The unit shall have controls provided by the manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
3. The wall mounted, hard wired remote sensor kit shall be provided in all zones (branch wiring is included in the kit).

2.4 CONTROLS

- A. All indoor units shall maintain the settings for: temperature setpoint, start/stop status, operating mode, fan speed, air flow direction in non-volatile memory each time they are changed. These setting shall not be lost upon a power loss event.
- B. All indoor unit settings shall be adjustable through the BMS system using the BACnet interface.
- C. The entire system shall automatically re start upon a power loss event.
- D. All indoor units shall be auto addressing. Manual addressing of the indoor unit shall not be acceptable.
- E. Control Wiring Requirements
 1. All control wiring shall be done per the control wiring drawings provided on the drawings.

2. All control wiring shall be 18 AWG, 2 conductor, stranded non-shielded cable.

F. Wall Mounted Remote Controller

1. In all zones a wall mounted Advanced Remote Controller shall be mounted 48" above the finished floor.
2. The Advanced Remote Controller shall be approximately 4.75" x 4.75" in size with a backlit 2.75" x 1.75" LCD display. Display information shall be selectable from English, French, or Spanish. Day of the week as well as time of day configurable for 12/24 hour clock shall be displayed. Display of temperature information shall be configurable for Fahrenheit or Celsius. The controller shall be able to display room temperature in one degree increments with a range of 0 - 176°F / 0-80°C.
3. The Advanced Remote Controller shall control the following grouped operations: On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto), independent Cooling and Heating setpoints in the Occupied mode and independent Cooling Setup and Heating Setback setpoints in the Unoccupied mode, fan speed, and airflow direction and have the ability to individually prohibit controller buttons. The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period.
4. The Advanced Remote Controller shall support auto-changeover mode for both heat pump and heat recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat according to the room temperature and temperature setpoint. Changeover to cooling mode shall occur at cooling setpoint + 1°F (0.5°C). Changeover to heating mode shall occur at heating setpoint - 1°F (0.5°C).
5. The room temperature shall be sensed at either the Advanced Remote Controller or the Indoor Unit return air temperature sensor (or remote mount sensor) dependent on the Field Setting configured through the remote controller.
6. The Advanced Remote Controller shall display an error code in the event of system abnormality/error. The controller shall also display the following system temperatures to assist service

**Carver Community Center Renovation
FOA 1201**

personnel in troubleshooting: Return Air Temperature, Liquid Line Temperature, Gas Line Temperature, Discharge Air Temperature (depending on unit), Remote Controller Sensor Temperature, and Temperature used for Indoor Unit Control.

G. I Touch Controller

1. The system shall be supplied with a touch screen Centralized Controller. This controller will allow for onsite setpoint changes if the BMS ever goes off line.
2. Each centralized remote controller shall be able to control up to a minimum of 128 indoor zones and 10 outdoor systems.
3. The I touch controller shall allow for connection to the internet for remote access to the system using Microsoft Explorer web browser.
4. The I touch controller shall provide e-mail and mobile phone malfunction reporting.
5. The centralized remote controller shall have the following features:
 - a. Change Operation: Start/stop, operation mode, temperature setting, fan speed, airflow direction.
 - b. Monitoring: Status, Malfunction identification, Malfunction code, filter sign, operation mode, temperature setting, fan speed, airflow direction.

H. BACnet Interface

1. The system shall be supplied with a BACnet IP interface. This interface shall allow the BMS to monitor and change certain values of the system.
2. The BACnet interface shall be a hardware based device and shall mount in the BMS control panel. A BACnet interface which is software based and must run on an IBM compatible computer is not acceptable.
3. The BACnet interface shall be capable of interfacing to a minimum of 40 outdoor systems and 256 indoor units.

**Carver Community Center Renovation
FOA 1201**

4. The interface shall be a BACnet Application Specific Controller (B-ASC) device profile compatible with BACnet (ANSI / ASHRAE-135)
5. The interface shall have BACnet IP Data Link Layer (Annex J)
6. The interface shall support COV – Change of Value, Property Array Index and Segmented Requests
7. The interface shall have IPV6 and Foreign Device Registration capability
8. The interface shall have BTL Certification (Operating System Version 6.2 and Later).
9. The interface shall provide as at a minimum the following points:
 - a. Monitoring points: indoor unit Start/stop status, All indoor unit Alarms, All outdoor unit alarms, indoor unit Malfunction codes, outdoor unit malfunction codes, indoor unit mode of operation, return air or space temperature, indoor unit filter inspection required, Outdoor unit compressor status, indoor unit fan status.
 - b. Writable points: indoor unit start/stop operation, indoor unit mode of operation, room temperature setting, indoor unit filter inspection reset, remote controller enable/disable, indoor unit fan speed setting, indoor unit air direction setting, forced system stop, forced thermostat disable,

2.5 REFRIGERANT PIPING

- A. All refrigeration piping shall be Type ACR hard drawn copper tubing and shall be precapped, precleaned and dry nitrogen charged at the factory. This piping shall be capped throughout the construction to prevent any foreign materials from entering the piping. Fittings shall be wrought copper solder joint type. Dry nitrogen shall be bled through piping while joints are being brazed. Joints shall be as follows:
 1. Copper to Brass - Silver Solder.
 2. Copper to Copper - Silfos.

**Carver Community Center Renovation
FOA 1201**

- B. Joints: Copper tubing connections shall be made up with 95/5 tin antimony solder or silfos, in accordance with the recommendations of the manufacturer or as specified hereinafter.
- C. Refrigerant Piping Insulation: Armstrong Armaflex insulation ½" thick with fittings covered with mitered sections of insulation and sealed with 520 adhesive. All insulation on outdoor installation shall be additionally protected with two (2) coats of Armaflex vinyl-lacquer type finish.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

- A. The system must be installed by a Daikin factory trained contractor/dealer. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor kids with complete knowledge of the HVAC system requirements. Untrained contractors who wish to bid this project may contact Thermal Equipment Sales at 859-255-9665 to arrange training prior to bid day. The training shall be made available locally to all interested contractors. All employees of the successful contractors that will be installing the system shall attend an installation training class, this class shall be provided locally.

3.2 INSTALLATION

- A. Install all components in accordance with manufacturer's recommendation.
- B. Install all components in a manner to provide clearances required for proper operation and maintenance.
- C. Install all compressor/condenser components as described on the drawings.
- D. Furnish equipment with charge of refrigerant and oil.
- E. Coordinate electrical and control connection required.

3.3 DEMONSTRATION

- A. Provide owner's maintenance personnel training as required to adjust, operate and maintain system.

PART 4 - HVAC EQUIPMENT ALTERNATE (GENERAL INFORMATION)

- 4.1 Daikin is the Basis of Design Manufacture. The non-basis of design shall include all cost associated with refrigerant piping differences, control wiring differences,

**Carver Community Center Renovation
FOA 1201**

electrical wiring differences, equipment cost differences, and BacNET interfacing differences. The non-basis of design equipment supplier shall provide to the mechanical engineer for review and to the bidding mechanical contractor a complete equipment data package. This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements, and physical dimensions. Nominal performance data is not acceptable. Non-basis of design systems must meet or exceed the heating and cooling design capacities at the design water and air temperatures, performance must be corrected for defrost, no exceptions.

The mechanical contractor shall request and receive the equipment data package 15 days prior to bid date and submit this package with the alternate bid.

- 4.2 The non-basis of design equipment supplier shall furnish a complete drawing package to the mechanical contractor 15 days prior to bid day for bidding and installation. The drawing format shall be .dxf or equivalent, on 30"x42" sheets. The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings. The non-basis of design equipment supplier shall prepare the following drawings:

HVAC Floor Plan
HVAC Refrigerant Piping Plan
HVAC Refrigerant Piping/Controls Details
HVAC Details
HVAC Schedules

The non-basis of design equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment suppliers system.

Provide (2) drawing package sets. Provide (1) drawing package in electronic format (.dxf files) on CD.

The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.

- 4.3 The equipment supplier shall submit as part of the equipment data package outdoor unit data sheets. Data sheets to include the following:

Capacities at project design conditions: Cooling
Cooling (Btu/h)

Cooling Input Power

**Carver Community Center Renovation
FOA 1201**

(KW)

Full Load EER

Capacities at project design conditions: Heating
Heating (Btu/h)

Heating Input Power
(KW)

Full Load COP

The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed flow rate, EWT and space conditions including de-rate factors for defrost if applicable and refrigerant piping losses.

Operating Temperature Range:
Cooling
Heating

Flow Rate per Module
(gpm)

Pressure Drop
(psi)

Power Supply:
Maximum Circuit Amps (MCA)
Maximum Overcurrent Protection Amps (MOP)
Maximum Starting Current (MSC)

Refrigerant:
Refrigerant Type/Charge
Control

Unit Data:
Max. Number of Indoor Units
Sound Pressure Level at 3ft. (dBA)
Weight (lbs)
Dimensions

- 4.4 The equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.

VARIABLE REFRIGERANT VOLUME (VRV) SYSTEM

238136 - 17

**Carver Community Center Renovation
FOA 1201**

Room Temperature (Cooling): 72 deg F
Room Temperature (Heating): 68 deg F

- 4.5 The non-basis of design equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:

Capacities at project design conditions:

Cooling (Btu/h)

Heating (Btu/h)

Air Flow (CFM)

Full Load EER

Full Load COP

External Static Pressure (ESP)

Electrical Data (MCA, MOP, MSC, RLA)

Weight (lbs)

Dimensions

END OF SECTION 238136

**Carver Community Center Renovation
FOA 1201**

SECTION 238239 - UNIT HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electric Cabinet Heaters
- B. Electric Unit Heaters
- C. Electric Ceiling Mounted Heaters

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 220500 - COMMON WORK RESULTS FOR MECHANICAL SYSTEMS
- D. See drawings for further conditions, requirements and schedules.

1.3 QUALITY ASSURANCE

- A. All electrical components and accessories shall be listed and labeled per requirements of NFPA 70, Article 100.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Chromalox, MSI, International, Markel, Sentinel, Becko, Trane, and TPI/Reddi.

2.2 ELECTRICAL CABINET HEATERS

- A. Basic Unit: Shall include chassis, coil, shall be fanwheel(s), housing(s), motor and insulation. Chassis shall be galvanized steel wrap-around structural frame with all edges flanged. Insulation is faced, heavy density glass fiber.
- B. Cabinet Finish: All cabinet parts shall be cleaned, bonderized, phosphatized, and flow-coated with baked-on primer. Provide final finish of spray applied baked-on enamel.

UNIT HEATERS

238239 - 1

- C. Electric Heating Coils: Hydronic type finned-tube construction with resistance elements inserted in tubes. Units factory wired with unit mounted heat switch, magnetic contactors, high temperature cutout safety control and fan override thermostat.
- D. Fans: Fan wheels shall be centrifugal, forward-curved, double width of aluminum.
- E. Motors: All motors shall have integral thermal overload protection and start at 78% of rated voltage. Motors shall operate satisfactorily at 90% of rated voltage on all speed settings and at 10% over voltage without undue magnetic noise. Temperature rise by winding resistance method shall not exceed 50 C (PSC motors) on high speed. All motors shall be factory run tested assembled in unit prior to shipping. Motor cords shall be quickly detachable at junction box by locking prong connector on vertical cabinet and wall hung units.
- F. Disconnect Switch: Factory wired, non-fusible in-housing.
- G. Electrical Performance: All cataloged models shall be wired in accordance with National Electric Code and be Underwriters' Laboratories, Inc., listed. Junction box for motor cord shall be provided unless otherwise specified.
- H. Provide factory standard discharge grilles.
- I. Filters: Provide 1" thick throwaway filter on all cabinet models.

2.3 ELECTRIC UNIT HEATERS

- A. Provide vertical unit heaters with heating and air delivery capacities as shown in schedule on drawings. The cabinet shall be made of 18 gauge die formed, furniture grade steel. Individual adjustable louvers with 30 degree downward stops shall be furnished to provide desired control of discharge air. All metal surfaces of the casing shall be phosphate coated to resist corrosion and finished in baked enamel. Heat to be of the draw-through air flow design.
- B. The electric heating bank shall consist of metal sheath heating elements. The elements shall have a copper clad steel sheath and corrosion resistance, and aluminum fins. Automatic reset thermal over-heat protection, shall be of the linear capillary type wired for instantaneous de-energizing in case of thermal overload. Heating bank to have protective air inlet louvers.
- C. Motors shall be of the totally enclosed, continuous heavy-duty all-angle operation equipped with built-in thermal overload protection.
- D. Fans shall be aluminum directly connected to fan motor, designed specifically for unit heat application.

**Carver Community Center Renovation
FOA 1201**

- E. Controls: Provide unit mounted thermostat to maintain space temperature unless otherwise noted.
- F. All heaters shall be U.L. listed and meet the requirements of the National Electrical Code.

2.4 ELECTRIC CEILING MOUNTED HEATERS

- A. Heater Section: The heater section shall consist of a 20 gauge steel chassis on which are mounted the heating elements, fan motor and blade, fan control, thermal cutout and 3-pole contactor. Heater section shall be completely prewired.
- B. Heater Elements: The heating elements shall be guaranteed for five years and shall be of non-glowing design consisting of 80/20 NiCh resistance wire, enclosed in a steel sheath, to which steel plate fins are brazed. The elements shall cover the entire air intake area to ensure uniform heating of all discharged air.
- C. Motor and Controls: The fan motor shall be impedance-protected, permanently lubricated and with totally-enclosed rotor. Fan control shall be bi-metallic, snap-action type and shall activate fan and heating element when the thermostat calls for heat and continue to operate the fan after the thermostat is satisfied and until all heated air has been discharged. Thermal cutout shall be bi-metallic snap-action type designed to automatically shut off heater in the event of overheating and reactivate the heater when temperature returns to normal.
- D. Operational Controls: Disconnect switch, and all interlock relays shall be installed within the heater enclosure.
- E. Recess Enclosure
 - 1. The box shall be designed for duty as a recessed rough-in box in masonry, T-Bar, or frame ceiling construction. The back box shall be 20 gauge galvanized steel and shall contain knockouts through which field wiring leads are brought. Enclosure to recess into a maximum 7 inches of ceiling space. An independent support system shall be used for T-Bar installation.
 - 2. The louvered recess faceplate shall be of 20 gauge cold rolled steel, phosphatized then electrostatically painted Antique White by a baked enamel process.
- F. Surface Enclosure
 - 1. The surface mounting plate shall be designed for duty as a rough-in box or masonry, T-Bar, or frame ceiling construction. The surface mounting plate shall be 20 gauge galvanized steel and shall contain knockouts through which

**Carver Community Center Renovation
FOA 1201**

field wiring leads are brought. Enclosure to extend a maximum of 16 inches into the heated space. An independent support system shall be used for T-Bar installation.

2. The louvered surface wrapper shall be a contoured aluminum extrusion and 20 gauge sheet metal combination with rounded corners. The surface wrapper shall be electrostatically painted Antique White by a baked enamel process.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all units and accessories in accordance with manufacturer's recommendations.
- B. Install all units in a manner to provide clearances for proper operation accessibility and maintenance.
- C. Coordinate electrical connections required.

3.2 DEMONSTRATION

- A. Provide Owner's maintenance personal training as required to adjust, operate and maintain heaters.

END OF SECTION 238239

**Carver Community Center Renovation
FOA 1201**

SUBMITTALS

In accordance with the requirements of the General Conditions and Supplementary General Conditions, the following information is required to be submitted for this Section. The Contractor shall submit 11 copies of the required information to Architect for approval within 30 days after notice to proceed.

ITEM DESCRIPTION	S H O P D R A W I N G S	C A T A L O G D A T A	P A R T S L I S T S	O P E R A T I N G M A N U A L	W I R I N G D I A G R A M	C E R T I F I C A T I O N	S A M P L E S	OTHER
Cabinet Heaters	X	X	X	X	X			
Unit Heaters	X	X	X	X	X			
Ceiling Mounted Heaters	X	X	X	X	X			

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.

1.2 SCOPE

- A. Include furnishing of all labor, materials, equipment and other related items required to complete the work called for and indicated on the Contract Drawings and specified for a complete system, including excavation, backfilling and tamping. Classification of excavation and payment for same shall be in accordance with applicable provisions of these specifications.
- B. The work covered by this section of the contract shall include the furnishing of all labor, materials, tools and equipment necessary to complete the electrical work as herein specified, or implied and as shown or implied on the contract drawings.
- C. All materials shall be new and the best of their respective kinds unless otherwise specified and shall be listed by UL and shall be so labeled. All equipment shall conform to the latest approved standards of the IEEE, NEMA, ANSI and OSHA.

1.3 ABBREVIATIONS OF ORGANIZATIONS AND PUBLICATIONS

NEC	- National Electrical Code
UL	- Underwriters Laboratories, Inc.
IPCEA	- Insulated Power Cable Engineers Association
ANSI	- American National Standards Institute
OSHA	- Occupational Safety Health Act
IMC	- International Mechanical Code

1.4 DRAWINGS AND SPECIFICATIONS

- A. The contract drawings and specifications are intended to cover all work enumerated under the respective headings. Examine all contract drawings and specifications to determine any references to work of an electrical nature and be guided accordingly in prosecuting the electrical work. The contract drawings are diagrammatic only, as far as final location is concerned. Any item of work not clearly included, specified or shown, and any errors or conflict between contract drawings, specifications, codes and field conditions shall be clarified by a written request to the architect prior to bidding; otherwise all labor and materials required to make good any damage or

**Carver Community Center Renovation
FOA 1201**

defect in finished work caused by such error, omission or conflict shall be provided at no additional cost to the Owner.

1.5 CODE COMPLIANCE

- A. The minimum standards for all electrical work shall be the 2011 revision of the National Electrical Code (NEC). Whenever and wherever OSHA and/or federal, state, and/or local laws or regulations and/or design require higher standards than the NEC, then these laws and/or regulations and/or design shall be followed.

1.6 WARRANTY

- A. All equipment shall be warranted for a period of at least one (1) year from the date of acceptance, as evidenced by date of substantial completion for the entire project or for the last phase of the project, whichever occurs later, against defective materials, design, and workmanship. In addition to the equipment warranty, the Contractor shall provide all repair and adjustment service necessary for the proper operation of the entire system for the length of the entire warranty period.. Upon receipt of notice from the Owner's representative of failure of any part of the warranted system or equipment during the warranty period, the affected part shall be replaced promptly with a new part without cost to the Owner. Upon failure to take action within 24 hours after being notified, the work will be accomplished by the Engineer at the expense of the Contractor. See General Conditions and individual equipment specifications. Note that the warranty period of time specified in this section represents the minimum warranty period required for work performed under specification Divisions 260000, 270000, and 280000. Where the General Conditions and/or individual equipment/system specifications require a warranty period of longer duration or earlier start date than specified in this paragraph, the longer duration/earlier start date shall supercede for those portions of work covered by that specification. In the event the contractor is notified of warranty issues but does not correct or address the warranty issues prior to the end of the specified warranty period, the contractor will not be relieved of the responsibility to correct the deficient items after the warranty end date has passed.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 COOPERATION

- A. Check with other trades on the scope of their work and coordinate on all locations of various items of equipment and outlets before they are finally placed and connected. Any relocation of material or equipment necessitated by failure to coordinate work shall be at no cost to the Owner.

**Carver Community Center Renovation
FOA 1201**

- B. Do not cut the work of any other trade without first consulting the Architect's representative. Repair any work damaged employing the services of the trade whose work is damaged.

3.2 INSPECTION AND CERTIFICATES

- A. Furnish electrical inspection by a licensed electrical inspector. Notify the electrical inspector in writing, immediately upon the start of the work with a copy of the notice to the architect. The inspector shall be scheduled for rough as well as finished work. Approval from the electrical inspector will not be allowed as reason for deviation from the contract drawing and specifications. All cost incidental to the electrical inspection shall be borne by the contractor.

3.3 CLEANING

- A. At the completion of the work required under this contract and just prior to acceptance by the Owner, thoroughly clean all exposed equipment fittings, fixtures and accessories.

3.4 CONNECTIONS TO EQUIPMENT BY OTHERS

- A. Provide all conduit, boxes and wire with required connections, including any disconnect switches called for by NEC to all electrically powered or controlled equipment furnished and set in place by others. Examine all divisions of the specifications and all contract drawings to determine location and size of all electrically powered or controlled equipment.
- B. Install and provide required connections to phase failure relays in all three-phase equipment provided by others. Phase failure relays will also be provided by others. Coordinate with work detailed in the Division 15000 specifications.

3.5 PHASING

- A. Verify the rotation of all three phase motors with the trade furnishing equipment. These motors shall be "bumped" or run uncoupled in the presence of the trade furnishing the equipment to insure proper rotation.

3.6 SPECIAL NOTE

- A. All openings in electrical equipment, enclosures, cabinets, outlets and junction boxes shall be by means of standard knockouts or shall be sawed or drilled. The use of a cutting torch is prohibited.

3.7 PIPE SLEEVES AND FIRE RATING OF OPENINGS

- A. Wherever conduit pass through floor slabs in other than slab on grade construction,

**Carver Community Center Renovation
FOA 1201**

steel sleeves shall be provided for each conduit. Sleeves shall project 3/8" above slab and spaces between conduit and sleeves shall be caulked with material which will provide a fire rating substantially the same as the unpierced floor.

- B. Holes through walls and ceilings, chases, shafts, etc., for the passage of cable or conduit shall be made so as to substantially preserve the integrity of the fire rating of such surfaces or passages in accordance with NEC 300-21.
- C. Where conduit penetrates the roof, such penetration shall be through an opening approved by manufacturer of the roof.

3.8 EXCAVATION AND BACKFILLING

- A. Perform all excavation and backfilling required for completion of work indicated on the contract drawings and specified herein. Classification of excavation and prices for excavation shall be in accordance with the applicable division of these specifications.
- B. Backfill material for conduit or direct bury cable unless otherwise specified and/or noted on the drawings, shall be clean earth, free from rock and debris, thoroughly tamped in six inch (6") layers to the finished grade.
- C. During the progress of the project, the premises shall be kept reasonably clean and free from accumulated rubbish and debris. Proper care shall be exercised to protect all trees, shrubbery, etc., in the vicinity of the work. All surplus earth shall be disposed of as directed by the architect.
- D. Compaction of backfill in place shall be 95% of maximum density.

3.9 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. At completion of the contract, the Owner shall be provided with three (3) bound copies of operations and maintenance instructions for the various items of the electrical equipment, including fire alarm system, standby generator, sound and clock systems, service equipment, lighting fixtures, etc.
- B. In addition to manufacturer's approved shop drawings, manual shall include: (a) A listing of equipment (identified in accordance with the drawings nomenclature, eg. LF-1, M.D.B. etc.) and distribution or supplier of the equipment. In case of lighting fixtures, the type replacement lamp including voltage and other necessary designation shall be included.
- C. Instructions shall be included for routine checking of circuit breakers and fused switches.
- D. Schematic drawings with actual values of resistors, capacitors, etc., for fire alarm

**Carver Community Center Renovation
FOA 1201**

system, sound system, etc., shall be included; where manufacturers parts numbers only are applicable, they shall be included.

- E. Detailed operating instructions for P.A. systems, clock systems, fire alarm systems and standby generator shall be included, as well as general maintenance procedures to be followed on such equipment. Manufacturers maintenance and operation manuals will be required where such are normally available with the equipment, but as such information is often of a general nature and applicable to various models of equipment, such information shall be supplemented by specified typed directions for the particular piece of equipment applicable to this project.

3.10 LABELING

- A. All lighting and power panels, telephone cabinets, TV cabinets and boxes, switches in distribution equipment, safety switches for remote equipment and all other items noted for labeling shall be properly identified in accordance with the designations shown on the drawings or the function they perform.
- B. Labels shall be 1/4" high, white letters on laminated phenolic engraving stock suitably cemented to the inside of the recessed panels and on the face of surface mounted panels and other equipment.
- C. Label ceiling grid below all above ceiling electrical items requiring maintenance. Examples of items to label are fire alarm duct detectors and low voltage lighting control relay cabinets. Labels shall be created with a P-touch type label maker and shall be made of black lettering on clear tape.

3.11 FISH WIRE

- A. All conduit required under this contract which do not receive conductors, shall be provided with a 14 gauge galvanized steel fish wire or approved nylon wire.

3.12 TEMPERATURE CONTROLS

- 1. All temperature control conduit shall be provided and installed by others. Refer to Mechanical specifications for information concerning temperature control conduit installation.
- 2. Electrical contractor shall provide 120V power to all HVAC, fire protection, ansul, sprinkler, sump, and plumbing control panels indicated on the mechanical, fire protection, and plumbing plans. Route 3 #12 in 3/4" conduit from the connection point at the control panel to the nearest 120V normal power electrical panel and terminate on a 20A/1P breaker installed in a space in the panel. Provide disconnecting means at the control panel as required. Coordinate all work with the temperature control/mechanical contractor.

**Carver Community Center Renovation
FOA 1201**

3.13 SHOP DRAWINGS

Submit the required number of copies of Shop Drawings including, but not limited to, these items:

1. Lighting Fixtures
2. Safety Switches
3. Switches and Receptacles
3. Fire Alarm
4. CCTV System
5. Communications

3.14 OWNER TRAINING/SUPPORT

- A. At a minimum, provide for on-site Owner training/support for:
 1. System commissioning, for systems when required per individual system specifications. Commissioning time shall not be taken from Owner training time.
 2. Initial Owner training, time as indicated in individual system specifications.

END OF SECTION 260500

SECTION 260510 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.

1.2 SCOPE

- A. Electrical demolition is required throughout the existing building as indicated on mechanical, electrical, and architectural drawings. All electrical equipment and devices shall be removed except for items noted on drawings and specifications as existing-to-remain. All exposed conduit and wiring including those exposed by demolition of walls and ceilings shall be removed. Where circuits or other electrical items feed through to adjoining spaces they shall be maintained or re-routed as required to be compatible with new work. See architectural, mechanical, and electrical drawings for more information on areas to demolish.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

- A. The contractor shall visit the site, prior to submitting bids and familiarize himself with existing field conditions relative to demolition work and routing, interferences and all other difficulties that may be encountered relative to this contract. Failure to visit the site shall not constitute sufficient reason to warrant a change order for difficulties not apparent in the contract documents.
- B. The contractor shall seal floor openings from removed conduits with thermo setting fire resistive compound.
- C. Any outlet boxes left empty after demolishing a device may be reused for installation of a new device if in close proximity to a new device going in, if box is at correct mounting height, and if outlet box and conduit are of sufficient size for new device. Otherwise, cover empty box with blank plate.
- D. If circuitry within the area of demolition serves equipment located outside the boundaries of the demolition, the continuity of the circuits shall be maintained as required to keep the equipment operational.

- E. The electrical contractor shall be responsible for damage caused by said contractor to existing-to-remain materials. Repair or replace damaged material or equipment as directed at no additional cost.
- F. Repairing, painting and patching of walls shall be by others, as described in other sections of the specifications.
- G. The owner has the option of retaining or rejecting all demolished materials. The electrical contractor shall be responsible for removing from the site any electrical-related material not claimed by the owner.
- H. **ELECTRICAL-RELATED ABATEMENT PROCEDURES**
 - 1. Due to the likely presence of ballast containing PCB's in existing light fixtures that are to be demolished, as well as mercury content in the fluorescent lamps, contractor is to assume that all existing-to-be-removed fluorescent fixtures contain such materials, and is to perform the following abatement procedures in accordance with all applicable Federal PCB and Mercury Abatement regulations.
 - 2. Electrician is to completely remove all light fixtures that are scheduled to be demolished.
 - 3. Electrical contractor is to supply, at the site, separate drums to contain the removed ballast and removed fluorescent lamps.
 - 4. Electrical contractor is to remove the ballast from the light fixtures while wearing gloves, and deposit the ballast into the drums.
 - 5. In the unlikely event that a ballast is found to be leaking, the electrical contractor has the option of going ahead and removing it and depositing it in the drums, or refusing to remove it by contacting the Owner and requesting that some other qualified person handle the leaking ballast, at which point, the Owner will handle the removal of that specific leaking ballast.
 - 6. Once all ballast and fluorescent lamps are removed and deposited into the drums, the electrical contractor will be responsible for picking up the drums and removing them from the site to be incinerated as required. Electrical contractor shall provide, to the Owner, copies of the manifest showing that the materials have been properly disposed.

END OF SECTION 260510

SECTION 260526 - GROUNDING AND BONDING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 260500 - Common Work Results for Electrical Systems is applicable to work under this section of the specifications.

1.2 SCOPE

- A. The conduit system and neutral conductors of the wiring system shall be grounded in accordance with NEC. Grounding conductors of the electrical system shall be as shown on the contract drawings, as required by NEC, and shall be extended in conduit to the water service.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Conductors shall be copper unless otherwise noted. Bonding conductor shall be bare copper #4 or #6 AWG. Conductors shall be rated for 600V. Conductors must meet ASTM and NEC requirements.
- B. Communication room grounding bar shall be insulated, copper minimum size of 4" x 20" x 1/4" pre-drilled holes.

2.2 GROUNDING ELECTRODES

- A. Grounding electrodes shall be 12' long copper tube, factory loaded with metallic salts. System shall not require maintenance for the life of the system.

2.3 Connectors

- A. Welded connectors shall be exothermic welds using kits recommended for the use intended. Use exothermic welds for exterior locations.
- B. Bolted connectors shall be copper with a minimum of two bolts applying pressure. Field verify pipe sizes and types prior to ordering clamps.

PART 3 - EXECUTION

- A. The conduit system and neutral conductors of the wiring system shall be grounded in accordance with NEC. Grounding conductors of the electrical system shall be as shown on the contract drawings and shall be extended in conduit to the water service. Connection to the water pipe shall be made by approved ground clamps. All unions, valves, meters, etc., in the water line shall be bonded in accordance with the NEC, from the point of ground connection to the point where the water pipe enters the ground.
- B. The entire grounding system shall be installed in a workmanlike manner and shall be inconspicuous.
- C. Continuity of the ground shall be maintained throughout the building. Continuity of equipment and raceway ground shall be insured by the use of double locknuts and insulated grounding bushings bonded to enclosures at service equipment, at all panelboards, safety switches, pull boxes, etc., and at the terminations of all conduit which (1) house the supply conductors to the main bus or main breaker of a panelboard; (2) house the conductors of any branch or feeder circuit protected at 60 amperes or more. Convenience outlets shall be grounded by means of a bonding wire attached to the outlet box in a manner approved by NEC Article 250-148.
- D. All equipment or device grounds at panelboards, service or distribution equipment shall be connected to ground bars in such equipment with set screw connectors.
- E. Whether shown on the drawings or not, all equipment and device feeders (receptacles, light fixtures, motor connections, etc.) shall include a green ground wire, sized per NEC, to be run in conduit with power conductors. Provide grounding connections per NEC 250.
- F. Building grounding electrode shall consist of a minimum of three electrodes installed 10' apart and shall be installed in a 6" diameter hole drilled approximately 13' deep. Top of electrode shall be 2" below grade. Install electrode per manufacturer's recommendations. Backfill around electrode on all sides with clay slurry per manufacturer's recommendations. Run #3/0 copper ground wire in 1-1/2" sch. 40 PVC conduit from grounding electrode to building service entry or ground bus and connect all electrodes together with similar #3/0 wire. All ground conduits shall be 36" minimum bury with warning tape 18" above conduit or exposed wire to building or to next electrode in trench. Close top of hole drilled for electrode with a conduit box with a cast iron marker. Set top of box/marker flush with grade. Provide a minimum of three grounding electrodes spaced at least 12' from nearest electrode. Mark locations of ground electrodes on as-built drawings.
- G. Provide a ground resistance test of completed electrode system at wire entry to building and provide a written report to Engineer.

**Carver Community Center Renovation
FOA 1201**

- H. Exterior padmounted transformers and switches shall be provided with two ground rods and a #2 AWG tinned-copper ground ring encircling the pad/switch 6" from pad on all sides. Using #2 AWG tinned-copper conductor, ground to the grounding system the padmounted equipment and all non-current carrying metal equipment associated.
- I. Install an insulated ground bar 6" above the floor in each communications wiring closet and at the telephone demarc. Connect each ground bar to the main building ground with #4 AWG insulated copper conductor run in conduit. Ground all metal, non-current carrying equipment in communications closets (equipment racks, cable tray, etc.) to ground bar with #6 AWG copper wire.
- J. All exterior lighting poles shall be provided with a separate grounding electrode in addition to the equipment grounding conductor in the branch circuit.
- K. Provide and install bond from service ground to building structure, as required. Install in accessible location. Bond directly to structure. Provide and install grounding connection from service ground to main metal water service entrances to building using bolted clamps or a lug connector. Connect to utility side of an dielectric fittings. Bond to ground conductor conduit on each end of conduit. Use braided bonding jumpers to ground across water meter. Bond to gas piping system equipment side of shutoff valve.

END OF SECTION 260526

SECTION 260533 - GENERAL MATERIALS AND INSTALLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 260500 - Common Work Results for Electrical Systems is applicable to work under this section of the specifications.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. In general, conduit shall be zinc-coated, rigid steel conduit and shall meet in all respects, the UL Standards for Rigid Steel Conduit. The conduit shall be metallized, galvanized, sherardized, or approved equal.
- B. Rigid thick wall conduit or IMC shall be installed underground, as required or noted and in all concrete construction. Schedule 40 PVC conduit may be used below grade on exterior and below slab on interior of building. All risers through slab shall be with rigid steel elbows and extensions.
- C. Electrical metallic tubing may be used in other places unless otherwise noted.

2.2 OUTLET BOXES

- A. Only zinc-coated or cadmium plated, sheet-steel boxes according to NEC, of a class to satisfy the conditions for each outlet shall be used in concealed work.
- B. Fixture outlet boxes in concrete ceilings shall be four (4") inch octagonal, concrete type, set flush with finished surfaces.
- C. For masonry or drywall construction, square cornered boxes measuring 3-3/4" high by approximately 2" wide and having interior device mounting holes shall be used.
- D. Single gang boxes for devices shall be not less than 2-1/2" deep unless limited by depth of construction and shall accommodate up to five #12 conductors. When construction depth permits, 3-1/2" deep boxes shall be used for devices where the number of conductors entering a single gang outlet is 6 to 8. Where more than 8 conductors enter an outlet housing a single device, boxes shall be 4" square by 2-1/8"

**Carver Community Center Renovation
FOA 1201**

deep to accommodate a maximum of 14 conductors and shall be provided with single device, square cornered tile wall covers of a suitable depth. Where construction depth is limited or to facilitate installation in cavity walls, 4" square boxes 1-1/2" deep may be used with single gang square cornered tile wallcovers in lieu of single gang, 2-1/2" or 3-1/2" deep boxes. Such installation shall be increased to conform with NEC requirements for conductors larger than #12 AWG.

- E. Where two or more devices are to be ganged at one outlet, 3-3/4" high boxes as specified above and with the required number of gangs shall be used. Each gang shall be subject to the same "fill" limitations as for single gang installation.
- F. All technology outlet boxes shall be a minimum of 1 3/4" deep. Note that combination boxes equivalent to Wiremold Wallsource series will be acceptable with proper divider. Also note that where communications boxes must include VGA and RCA-audio jacks for projectors, two gang boxes, or larger, may be required. Size accordingly.

2.3 WIRES AND CABLES (CONDUCTORS)

A. LOW VOLTAGE (0 - 600V)

- 1. All conductors shall be copper unless otherwise specified.
- 2. Insulation unless otherwise noted shall be thermoplastic Type THHN-THWN. The color code shall be in accordance with the National Electric Code.
- 3. Branch circuit conductors shall be not smaller than No. 12 A.W.G. Branch circuits longer than 100' shall be run with minimum No. 10 A.W.G., circuits longer than 200' shall be run with No. 8 A.W.G., etc. Conductors for signal and pilot control circuits may be No. 14 A.W.G.
- 4. All building wires shall be as manufactured by Capital, General Electric, General Cable, American, Southwire, US Wire or approved equal.

2.4 JUNCTION BOXES AND TERMINAL CABINETS

- A. All junction and terminal cabinets used under this contract shall be constructed of code gauge, galvanized steel and shall be as manufactured by Steel City, Appleton, O-Z/Gedney, RACO, Killark, or approved equal.

PART 3 - EXECUTION

3.1 CONDUIT

GENERAL MATERIALS AND INSTALLATION

**Carver Community Center Renovation
FOA 1201**

- A. Exterior below grade PVC shall be concrete encased below vehicle drives and parking areas. Exterior conduit shall have minimum size of 1" and shall have minimum bury of 30". Bury with yellow marking tape 12" above conduit and marking/tracing wire adjacent to conduit for entire length.
- B. Interior below slab PVC shall have 3" of cover between slab and conduit. If rock is present, provide 4" pad of same material as backfill. All conduit shall be embedded in gravel or soil subgrade below concrete slab on grade. Conduit may not be embedded in slabs.
- C. All thick wall terminals shall be capped with insulating bushings. Electrical metallic tubing shall be terminated with connectors with insulated throat. Metallined terminating fittings will not be acceptable. All terminating fittings shall be secured to box or cabinet with double lock-nut type of construction.
- D. Couplings and connectors for electrical metallic tubing shall be steel and shall be of the compression type. Set screw and indentation type connectors will not be acceptable, except that approved type steel set screw connectors may be used on EMT 2-1/2" or larger and on rigid conduit unless otherwise noted.
- E. Runs of conduit or tubing shall have supports spaced in accordance with the NEC, and exposed conduit shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends. Bends or offsets shall be avoided where possible but where necessary shall be made with an approved conduit bending machine. Conduit or tubing which has been crushed or deformed in any way shall not be installed. Expansion fittings or other approved devices shall be used to provide for expansion or contraction where conduit or tubing crosses expansion joints. Conduit and tubing shall be supported on an approved type of ceiling trapeze, beam clamps, strap hangers, or pipe straps, secured by means of toggle bolts on hollow masonry units, expansion shields in concrete or brick and machine screws on metal surfaces. The use of tie wire for suspending conduits or securing same to joists, purlins, beams, etc., will not be allowed. Conduit shall be securely fastened to all sheet metal outlets, junction and pull boxes with double galvanized locknuts and insulating bushings.
- F. Conduit and tubing shall be installed in such manner as to insure against trouble from the collection of trapped condensation, and all runs shall be arranged so as to be devoid of traps wherever possible.
- G. All necessary precautions to prevent the lodgment of dirt, plaster, or trash in conduit or tubing, fittings and boxes during construction shall be taken. A run of conduit or tubing which has become clogged shall be entirely freed of these accumulations or shall be replaced. All conduit in floors or below grade shall be swabbed free of debris or moisture before wires are pulled.

**Carver Community Center Renovation
FOA 1201**

- H. All underground conduit and conduit below slab shall be protected with (2) heavy coats of asphaltum paint.
- I. The final 18 inch section of conduit connecting each motor shall be liquid tight flexible type.
- J. All conduit shall be installed concealed unless otherwise noted or shown on the drawings.
- K. No conduit smaller than 3/4" shall be used except as noted. No flexible conduit smaller than 1/2" shall be used except as permitted by NEC 348. Flexible conduit shall be used only for light fixture whips unless otherwise noted.
- L. All conduit, required under this contract, which do not receive conductors, shall be provided with 14 gauge copper or galvanized steel pull wires for future installation of the conductors by others.
- M. Conduit shall be run parallel or perpendicular to building structure and shall be installed a minimum of 4" away from roof decking.

3.2 OUTLET BOXES

- A. Outlets shall be installed in the locations shown on the contract drawings. The general building plans shall be studied in relation to the spaces surrounding each outlet in order that work under this division of the specifications may fit the work required under other divisions. When necessary, outlets shall be relocated so that when fixtures or other fittings are installed they will be symmetrically located according to room layout and will not interfere with other work or equipment.
- B. Boxes shall be installed in a rigid and satisfactory manner either by wood screws on wood, expansion shields on masonry, or machine screws on steel.
- C. All supports required for outlet boxes in addition to that furnished under the general building construction, shall be furnished and installed under this division of the specifications. All supports shall be steel.
- D. Partitions shall be provided in ganged boxes as required for conformity with NEC 380-8.
- E. Where tile covers are used, they shall be of sufficient depth to bring the box opening within 1/4" of the finished wall surface.
- F. Provide and install blank metal cover plates for all boxes which do not receive devices.

**Carver Community Center Renovation
FOA 1201**

3.3 WIRES AND CABLES (CONDUCTORS)

A. LOW VOLTAGE (0 - 600V)

1. Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized where required.
2. Wire connectors of insulating materials or solderless pressure connectors properly insulated shall be utilized for all splices and wiring where possible. Rubber and friction tape shall conform to NEC and be UL approved. Vinyl plastic tape will be acceptable in lieu of rubber and friction tape. For branch circuit wires sizes #6 and smaller, and for fixture wiring, all splices shall be made with approved type crimp-on sleeves with separate outer insulating cap. In lieu of this, preinsulated, twist on torsion spring type connectors equal to "Scotchlok" may be utilized. The use of threaded connectors with integral insulation of bakelite or other material will not be allowed.

3.4 SURFACE RACEWAY

- A. Paint raceway to match wall.

3.5 COMMUNICATIONS CONDUIT, AND BOXES

- A. All technology outlets shall be located adjacent to 120V outlets shown on corresponding power drawings.

END OF SECTION 260533

**Carver Community Center Renovation
FOA 1201**

SECTION 262000 - ELECTRICAL DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 260500 - Common Work Results for Electrical Systems is applicable to work under this section of the specifications.

1.2 MOTOR CONTROLS

- A. Unless specifically indicated in Division 260000 of the Specifications or shown otherwise on the Contract Drawings, all starters for mechanical equipment are furnished under other sections of these Specifications.
- B. All starters, including those furnished under other sections of the Specifications shall be installed under this section of the Specifications, including all conduit, wire and boxes required for power connection to line and load terminals of the starter and to the motor.

PART 2 - PRODUCTS

2.1 DRY TYPE TRANSFORMERS - Not Applicable

2.2 PANELBOARDS - Not Applicable

2.3 SAFETY SWITCHES

- A. In general, safety switches shall be quick-make, quick-break, fused or unfused as required or specified, rated 240 or 600 volts as required and shall be Type A, Heavy Duty, Square D or equivalent. Each switch shall have the capacity indicated. Exterior switches shall be NEMA 3R type.
- B. Safety switches for single phase motors not having thermal overload shall be as manufactured by Square D or equivalent, single or two pole as required. Each switch shall be provided with a thermal heater of the correct size for the motor on which installed.
- C. All safety switches shall be of one manufacturer insofar as possible.

**Carver Community Center Renovation
FOA 1201**

2.4 FUSES

- A. Fuses 600 amperes and less shall be current limiting with an interrupting capacity of 200,000 amperes and time delay of 10 seconds at 500% rating. They shall be Bussman Fusetron dual element fuses or approved equal by Littlefuse.

PART 3 - EXECUTION

3.1 PANELBOARDS

- A. New directory cards shall be filled in (typewritten) showing circuit numbers, description, and room numbers and room numbers shall apply to final signage room numbers and not to the room numbers on the drawings.

3.2 SAFETY SWITCHES

- A. Each motor shall be provided with a disconnecting means where required by the NEC, whether or not indicated on the contract drawings. A circuit breaker in a panelboard will be accepted as a disconnect means if located within sight of the motor. A quick-break, quick-make, general use tumbler or snap switch shall be acceptable for capacity less than 30 amperes, provided the ampere rating of the switch is at least double the rating of the controlled equipment and provided the required running protection is supplied by other means.

3.3 FUSES

- A. Fuses shall not be installed in safety switches or panelboards until equipment is ready to be energized.

3.4 LABELING

Provide engraved phenolic labels for the exterior of every switchgear/panelboard and for every circuit breaker in main distribution and sub-distribution boards. Panelboard labels shall include the name of the panelboard. Circuit breaker labels shall include the load served by the circuit breaker.

END OF SECTION 262000

**Carver Community Center Renovation
FOA 1201**

SECTION 262700 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 260500 - Common Work Results for Electrical Systems is applicable to work under this section of the specifications.

PART 2 - PRODUCTS

2.1 SWITCHES

- A. All switches shall be of the flush tumbler type. All wall switches shall be rated at 20 ampere, 277 volts.
- B. Line voltage switches shall be specification grade, shall be rated for 20A, 120/277V, and shall be Hubbell #1221 (single-pole), Hubbell #1223 (three-way), Hubbell #1224 (four-way) or equivalent from Pass & Seymour CSB20AC series, Leviton 1221-2 series.
- C. Provide key operated switches where indicated. Key operated switches shall be barrel type Hubbell #1222RKL or equivalent from Pass & Seymour or Leviton.
- D. Low voltage switches shall be momentary contact, specification grade, three-position, center off switches Hubbell #1557 or equivalent from Pass & Seymour or Leviton. Provide three-position barrel type key operated where indicated.

2.2 RECEPTACLES

- A. Convenience outlets shall be heavy-duty, specification grade, 20 amp rated, Hubbell No. 5362, Leviton No. 5362 series, or Pass & Seymour No. 5362 series, of the grounding type. Provide GFI type receptacles of the same product series where required.
- B. GFI weatherproof duplex outlets shall be fully UL 943 compliant, equivalent to Hubbell No. GF 5362A with a Hubbell WP26M cast aluminum cover, or equal by Pass & Seymour, or Leviton.

2.3 PLATES

WIRING DEVICES

**Carver Community Center Renovation
FOA 1201**

- A. All plates for concealed devices shall match existing.
- 2.4 All wiring devices shall be of one manufacturer and color shall match existing..

PART 3 - EXECUTION

- 3.1 Install all device boxes and devices level and straight in wall.

END OF SECTION 262000

SECTION 275100 - COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 260500 - Common Work Results for Electrical Systems is applicable to work under this section of the specifications.

1.2 COMMUNICATIONS SYSTEM

A. Scope and Related Documents

This section of the Division 16 specifications includes the furnishing of all labor, equipment, materials and the furnishing, installing, labeling and testing of all passive data and voice cabling (including fiber optics), technology outlet cover plates and inserts, distribution frame equipment racks, cross connect blocks/patch panels, and voice and fiber interface panels, as shown on the drawings and specified herein.

The requirements of the conditions of the Contract, Supplementary Conditions and General Requirements apply to the work specified in this section.

All equipment listed in this section of the specifications shall be UL listed and shall conform to NEC, EIA/TIA, IEEE and all other applicable requirements and standards.

The System shall have a minimum 1-year labor and 5-year product warranty.

B. Documentation

Contractor is to provide to the owner a complete network documentation package upon completion of the project. The package shall include:

- 1. As built drawings - must show all network device locations and general cable routing.

C. Testing and Test Records

Contractor must supply to the owner and engineer a completed set of cable test records. The records shall indicate run numbers, room numbers, patch panel numbers, port numbers, cable length, pair 1 test, pair 2 test, pair 3 test, pair 4 test,

**Carver Community Center Renovation
FOA 1201**

ground test, and the initials of the person who tested it. Testing shall be per IEEE Standards using a Flude DSP-400 LAN Cable Tester and shall include, but not be limited to these tests:

1. Resistance
2. Impedance
3. Relative power loss test for fiber optic cable
4. Cross talk
5. Length
6. Proper pinning/termination
7. Tension testing during installation for fiber optic cable
8. Attenuation
9. Grounds
10. Shorts
11. Continuity
12. Loss

Unsatisfactory test results will require the contractor to correct the system, at no cost to the owner, before acceptance of the work will be given.

The following items will be tested for operational performance:

1. Unshielded twisted pair cable for voice and data
2. Fiber-optic cable
3. Passive network components
4. Miscellaneous supporting equipment

End to end continuity, performance, and diagnostic tests should be the final tests performed in all cases.

PART 2 - PRODUCTS

1.1 COMMUNICATIONS SYSTEM

A. Cable Specifications

The cable used for voice and data shall be category 5e, four pair, 24 AWG solid, 100 ohm, unshielded twisted pair cable with the following properties (leave 5' slack cable coiled at the receptacle and 15-20 feet of slack cable at the wiring closet.

The category "5e" cable shall be equivalent in performance specifications or shall exceed the performance specifications of Superior Essex NextGain Category 5e series cabling.

All Cat. 5e data cabling shall be blue.

COMMUNICATIONS SYSTEMS

**Carver Community Center Renovation
FOA 1201**

All Cat. 5e voice cabling shall be gray.

- B. Data and voice connectors shall be Panduit or equivalent RJ-45 type. Label each insert either "Voice" or "Data." Voice jacks shall be ivory, data jacks shall be orange.

PART 3 - EXECUTION

3.1 COMMUNICATIONS SYSTEM

- A. Wiring Closets (MDF's and IDF's)

NOTE: Prior to installing any work in any wiring closet, the electrician shall have a meeting on-site with the engineer and Owner's representatives to locate equipment racks and all closet components. All work shall be located within the closets per the Owner's directions.

- B. Conduit Routing

1. The bend radius of any conduit of trade size 2" or less shall be six times the internal conduit diameter. For any conduit greater than 2", the bend radius shall be ten times the internal conduit diameter.
2. This table demonstrates the capacity of various trade size conduits based upon the quantity and size of cable to be pulled into conduit. All communications conduit sizes, even those specified on the drawings, shall be verified with this table and shall be adjusted, as required, to meet these recommendations. This table assumes conduits will have no more than two 90 degree bends and no runs of conduit longer than 100 feet between pull points.

Inside Diameter mm	Trade Size	Cable Outside Diameter mm (in)									
		3.3 (0.13)	4.6 (0.18)	5.6 (0.22)	6.1 (0.24)	7.4 (0.29)	7.9 (0.31)	9.4 (0.37)	13.5 (0.53)	15.8 (0.62)	17.8 (0.70)
16	½	1	1	0	0	0	0	0	0	0	0
21	¾	6	5	4	3	2	2	1	0	0	0

**Carver Community Center Renovation
FOA 1201**

27	1	8	8	7	6	3	3	2	1	0	0
35	1- 1/4	16	14	12	10	6	4	3	1	1	1
41	1- 1/2	20	18	16	15	7	6	4	2	1	1
53	2	30	26	22	20	14	12	7	4	3	2
63	2- 1/2	45	40	36	30	17	14	12	6	3	3
78	3	70	60	50	40	20	20	17	7	6	6
91	3- 1/2							22	12	7	6
103	4							30	14	12	7

3. If a conduit run requires more than two 90 degree bends, then provide a pull box between sections with two bends or less. If a conduit run requires a bend between 100 and 180 degrees (a "reverse" bend), then insert a pull box at each end of the "reverse" bend. If a conduit run must have a third 90 degree bend between pull points, then derate the conduit capacity by 15% according to the table above.
4. The ends of all conduits shall be reamed and fitted with an insulated bushing.
5. When pull boxes are inserted into a conduit run, the pull box shall be inserted in a straight run of conduit. Pull boxes shall not be used to make bends or offsets in conduits. Conduit shall enter a pull box on one side and shall exit the pull box directly across from the entrance point. Pull boxes shall be inserted in conduit runs where the conduit run is more than 100 feet long or where the conduit includes bends as described above. See this table for sizing pull boxes (note that the length dimension corresponds with the direction the conduit is running):

Maximum Trade Size of Conduit	Size of Box			For Each Additional Conduit Increase Width
	Width	Length	Depth	
21 mm (3/4)	100 mm (4 in)	300 mm (12 in)	75 mm (3 in)	50 mm (2 in)
27 mm (1)	100 mm (4 in)	400 mm (16 in)	75 mm (3 in)	50 mm (2 in)
35 mm (1-1/4)	150 mm (6 in)	500 mm (20 in)	75 mm (3 in)	75 mm (3 in)

**Carver Community Center Renovation
FOA 1201**

41 mm (1-1/2)	200 mm (8 in)	675 mm (27 in)	100 mm (4 in)	100 mm (4 in)
53 mm (2)	200 mm (8 in)	900 mm (36 in)	100 mm (4 in)	125 mm (5 in)
63 mm (2-1/2)	250 mm (10 in)	1050 mm (42 in)	125 mm (5 in)	150 mm (6 in)
78 mm (3)	300 mm (12 in)	1200 mm (48 in)	125 mm (5 in)	150 mm (6 in)
91 mm (3-1/2)	300 mm (12 in)	1350 mm (54 in)	150 mm (6 in)	150 mm (6 in)
103 mm (4)	375 mm (15 in)	1520 mm (60 in)	200 mm (8 in)	200 mm (8 in)

E. Cable Routing

1. The following is a chart of minimum distances that UTP must be run from common sources of EMI (electromagnetic interference):

<u>EMI SOURCE</u>	<u>MINIMUM DISTANCE</u>
Fluorescent Lighting	12 inches
Neon Lighting	12 inches
Unshielded power cable 2 KVA or less	5 inches
Unshielded power cable over 2 KVA	39 inches
Transformers and Motors	39 inches

2. Whenever possible, avoid running UTP in locations where temperature will be below 40 degrees Fahrenheit or above 115 degrees Fahrenheit. Humidity should normally be in the range of 8-80%.
3. All data and voice cabling is to be routed throughout building utilizing bridged ring path and conduit. Workstation drops shall be in 1" conduit to above ceiling.
4. From all individual data and voice outlets, run the appropriate cabling to the wiring closet (room 114). The quantity and uses of cables needed at each outlet location are noted adjacent to each outlet on the technology drawing. No cable runs are to exceed 290 feet. Terminate each cable at the workstation faceplate and leave the other end coiled up with an additional 25' of cable in room 114. Coordinate with owner for location of owner provided head-end equipment. Follow EIA/TIA 568A or 568B standard for terminations as determined by owner.

F. Labeling

Every component of the technology wiring system must be labeled. All cables must be labeled to show the source and destination. All labels must be easily viewed. All cables, components and device identities must be unique. All labels must be permanent and typed.

**Carver Community Center Renovation
FOA 1201**

All faceplates and wall boxes to which faceplates are attached must be labeled. Box labeling may be hand-printed with an indelible marker directly on the inside of the box. Label each box with the room number of its location. If two or more boxes are located within one room, label each box with the room number followed by the letter "a", "b", "c" etc. so that each box has a unique label.

Each communications faceplate location will be marked alphabetically and begin clockwise around the room from the main entrance. All jacks in each faceplate will be labeled numerically. Example: 102-A2 indicates room 102, faceplate A, jack 2. All faceplates labels must be machine generated.

All UTP cabling must be labeled within 6 inches of the attached connector and within 12 inches of the attached connector at the distribution location. Label must indicate the room designation and the faceplate circuit of the cable followed by the serving distribution frame or punchblock. For example, label "102-B1/RCE-2" indicates that the cable serves room 102, faceplate B, connection 1 and comes from punchblock labeled RCE-2. Patch panels shall also be labeled. All ports in equipment racks shall be sequentially ordered according to their labeling room number.

G. Terminations Standard

Follow EIA/TIA 568A or 568B per owner's direction.

H. Plates and Devices

Provide Panduit category 5e connectors or equivalent in each communications outlet box faceplate of the number and of the type shown on the drawings.

END OF SECTION 275100

**Carver Community Center Renovation
FOA 1201**

SECTION 282300 - CAMERA SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 260500 - Common Work Results for Electrical Systems is applicable to work under this section of the specifications.

1.2 Scope

- A. The contractor shall furnish and install all equipment including, but not limited to, outlet boxes, conduit, wiring, color cameras, monitor, etc. as shown on the plans and as specified, and all other equipment necessary to provide a complete and operating system.

1.3 DESCRIPTION

- A. The camera system equipment shall be provided as indicated on drawings.

PART 2 - PRODUCTS

2.1 Furnish and install equipment as indicated on drawings.

2.2 Provide all miscellaneous hardware, cabling (including cabling from cameras to head-end), terminations and installation for a 100% complete and operational system

2.3 Hardware, Cabling, and Installation

- A. Provide all miscellaneous hardware, cabling (including cabling from cameras to headend equipment), terminations, and installation to provide a 100% complete and operational system. Plenum rated cabling shall be concealed above lay-in ceilings and shall be run in conduit. Camera cabling to be combination coax/power cable in common, plenum-rated jacket.

PART 3 - EXECUTION

3.1 Furnish and install new CCTV cameras where shown on the drawings and as specified herein. All cameras are to have appropriate mounting means. Connect all cameras to camera DVR and power supply via siamese cabling.

**Carver Community Center Renovation
FOA 1201**

3.3 Owner shall participate in the focusing and aiming of all new cameras.

3.4 Owner Training

- A. Provide up to eight hours of Owner Training to be scheduled at Owner's convenience. Owner training session shall be video-taped by contractor and two copies of video tape shall be turned over to Owner at end of training session.

END OF SECTION 282300

SECTION 283111 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 260500 - Common Work Results for Electrical Systems is applicable to work under this section of the specifications.

1.2 DESCRIPTION

- A. This section of the specifications includes the furnishing, installation, and connection of the fire alarm devices as required to extend the existing Edwards fire alarm system into the renovated areas as indicated on the drawings.

1.3 BASIC PERFORMANCE - NOT APPLICABLE

1.4 BASIC SYSTEM FUNCTIONAL OPERATION - NOT APPLICABLE

1.5 SUBMITTALS

- A. Shop Drawings
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include manufacturer's name (s), model numbers, ratings, power requirements, etc.

1.6 SOFTWARE MODIFICATIONS - NOT APPLICABLE

1.7 CERTIFICATIONS - NOT APPLICABLE

1.8 GUARANTY

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.9 POST CONTRACT MAINTENANCE - NOT APPLICABLE

**Carver Community Center Renovation
FOA 1201**

1.10 APPLICABLE STANDARDS AND SPECIFICATIONS - NOT APPLICABLE

1.11 APPROVALS - NOT APPLICABLE

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL

- A. All equipment and components indicated on drawings shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.
- B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g. detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.2 CONDUIT AND WIRE

A. Conduit

- 1. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
- 2. All wiring shall be installed in conduit or raceway. All conduit backboxes shall be red.
- 3. Cable must be separate from any conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.
- 4. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with the transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
- 5. Conduits shall not enter the Fire Alarm Control Panel., or any other remotely mounted Control Panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.

**Carver Community Center Renovation
FOA 1201**

6. Conduit shall be 3/4 inch (19.1 mm) minimum.
7. All fire alarm horns and strobes shall be surface mounted or mounted on red back boxes. Vandal resistant cages shall be installed over fire alarm horns and strobes in restrooms, locker rooms, and gymnasiums.
8. The cable tray is to hold computer data, voice, security, and television cabling only. No other system's cabling shall be installed within nor supported from the cable tray. The Intercom/Clock System cabling shall be installed within conduit where it runs down in walls, but where it runs above ceiling, it may be run parallel/perpendicular to the building structure in plenum rated cabling installed in D-rings or bridle rings with a maximum 12" sag. All fire alarm system cabling shall be installed in conduit.

B. Wire

1. All fire alarm system wiring shall be new
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wiring used for the multiplex communication loop shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. The system shall support up to 1,000 ft. of untwisted, unshielded wire. The system shall permit use of IDC and NAC wiring in the same conduit with the communication loop.
5. All field wiring shall be completely supervised.
6. The Fire Alarm Control panel shall be capable of T-Tapping Class B (NFPA Style 4) Signaling Line Circuits (SLC's). Systems which do not allow or have restrictions in, for example, the amount of T-Taps, length of T-Taps etc., are not acceptable.

C. Terminal Boxes, Junction Boxes and Cabinets

1. All boxes and cabinets shall be UL listed for their use and purpose.

**Carver Community Center Renovation
FOA 1201**

- D. Initiating circuits shall be arranged to serve like categories (manual, smoke, water flow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
- E. The Fire Alarm Control Panel shall be connected to a separate dedicated branch circuit which shall be labeled as Fire Alarm. Fire Alarm Control Panel Primary Power wiring shall be 12 AWG. The control Panel Cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2.3 MAIN FIRE ALARM CONTROL PANEL

- A. The existing FACP is identified on the drawings and shall remain in service. Provide all hardware and software modifications necessary to extend the system as indicated on the drawings.

2.4 SYSTEM COMPONENTS

A. Programmable Electronic Sounders

- 1. Electronic sounders shall operate on 24 VDC nominal.
- 2. Electronic sounders shall be field programmable, without the need for special tools, to provide a temporal type pattern/tone with an output sound level of at least 90 DBA measured at 10 feet from the device.
- 3. Electronic sounders shall be flush mounted.

B. Strobe Lights

- 1. Shall operate on 24 VDC nominal.
- 2. Shall meet the requirements for the ADA as defined in UL standard 1971 and shall meet the following criteria:
 - A. The maximum pulse duration shall be 2/10ths of one second.
 - B. The strobe intensity shall meet the requirements of UL 1971.
 - C. The flash rate shall meet the requirements of UL 1971.
 - D. The appliance shall be placed 80 in (2,030 mm) above the highest floor level within the space, or 6 in (152 mm) below the ceiling, which ever is the lower.
 - E. Strobe flash rates shall be synchronized.
- 3. Strobe intensity shall be a minimum of 75 candela.

C. Audible/Visual Combination Devices

FIRE ALARM SYSTEM

**Carver Community Center Renovation
FOA 1201**

1. Shall meet the applicable requirements of Section A listed above for audibility.
2. Shall meet the requirements of Section B listed above for visibility.

D. Addressable Devices - General

1. Addressable Devices shall provide an address-setting means using rotary decimal switches.
2. Addressable Devices shall use simple to install and maintain decade (numbered 1 to 10) type address switches. Devices which use a binary address setting method, such as a dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.
3. Detectors shall be intelligent and addressable, and shall connect with two wires to the Fire Alarm Control Panel Signaling Line Circuits.
4. Addressable smoke detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs shall be optional through the system field program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. Smoke detector sensitivity shall be set through the Fire Alarm Control Panel and shall be adjustable in the field through the field programming of the system.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. An optional base shall be available with a built-in (local) sounder rated at 85 DBA minimum.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

9. Detectors shall also store on internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

E. Addressable Pull Box (manual station)

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset. Manual pull stations, fire alarm control panel, annunciator, etc. shall be keyed alike.
3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.
4. Stations shall be suitable for semiflush mounting and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

F. Intelligent Photoelectric Smoke Detector

1. The detector shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
2. Furnish where shown on the drawings, intelligent early warning laser detector, notifier model #LPX-751VIEW.

G. Intelligent Thermal Detector

1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via (2) two wires to the fire alarm control panel signaling line circuit. Up to 99 intelligent head detectors may connect to one SLC loop.

H. Intelligent Duct Detector

1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP,

**Carver Community Center Renovation
FOA 1201**

and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire glass throughout the areas served by the duct system.

I. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
2. The monitor module shall mount a 4-inch square, 2-1/8 inch deep electrical box.
3. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1 1/4 inch x 1/2 inch. This version need not include Style D or an LED.

J. Two Wire Detector Monitor Module

1. Addressable monitor shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contract device).
2. The two-wire monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box with an optional surface backbox.
3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with one control panel.

K. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.

3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp to inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact.
4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of .6 amps at 30 VDC.

L. Isolator Module

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall mount in a standard 4-inch deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

M. LCD Annunciator

1. The LCD annunciator shall display all alarm and trouble conditions in the system, and shall be supervised and remotely located.
2. LCD Annunciator shall be capable of the following system functions:
Acknowledge, Signal Silence and Reset.
3. Remote Annunciator to be provided, where shown on drawings, flush mounted, remote, and is to provide all pertinent displays. Provide wiring in conduit, as required back to main fire alarm control panel. Annunciator shall not require local 120V power.

**Carver Community Center Renovation
FOA 1201**

- N. Electromagnetic door holders to be Notifier FM series 24 volt AC/DC, wall-mount or floor mount as required. Door holders are to hold all fire and smoke barrier doors open, where shown on drawings, until released by the activation of a smoke detector or other switching device. Door holders are to be furnished and installed with thru-bolted hardware.
- O. Batteries
 - 1. Shall be 12 volt, Gell-Cell type (two required).
 - 2. Battery shall have sufficient capacity to power the fire alarm system for 4 hours.
 - 3. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage. All fire alarm junction box covers to be painted red. All fire alarm system wiring shall be conduit.
- C. All fire detection and alarm systems devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- D. All new components shall be 100% compatible with the existing Edwards system.

3.2 TEST

- A. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.
- B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- C. Close each sprinkler system flow valve and verify proper supervisory alarm at the

FACP.

- D. Verify activation of all flow switches.
- E. Open initiating device circuits and verify that the trouble signal actuates.
- F. Open and short signaling line circuits and verify that the trouble signal actuates.
- G. Open and short Notification Appliance Circuits and verify that trouble signal actuates.
- H. Ground all circuits and verify response of trouble signals.
- I. Check presence and audibility of tone at all alarm notification devices.
- J. Check installation, supervision, and operation of all intelligent smoke detectors using the Walk Test.
- K. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- L. The manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3 FINAL INSPECTION

- A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.
- B. Contractor shall coordinate with owner's current monitoring service as required.

3.4 INSTRUCTION - NOT APPLICABLE

3.5 SUBMITTALS

- A. Fire alarm manufactured/supplier shall submit all required fire alarm system drawings and information to State Fire Marshall as necessary to obtain all required approvals.

3.6 PROGRAMMING AND CERTIFICATION

- A. Provide all re-programming and re-certification necessary to incorporate the added

**Carver Community Center Renovation
FOA 1201**

devices as required.

END OF SECTION 283111