



HARRIMAN

Jewish Community Alliance of
Southern Maine
Portland, Maine

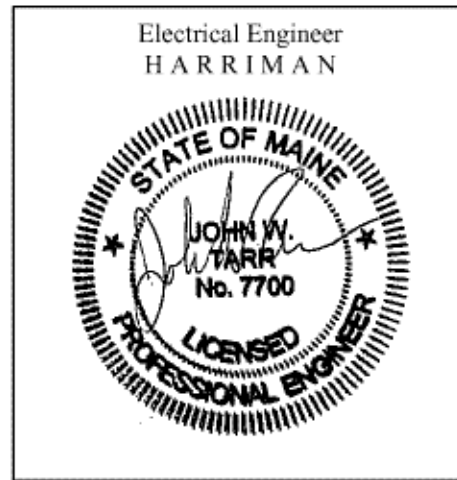
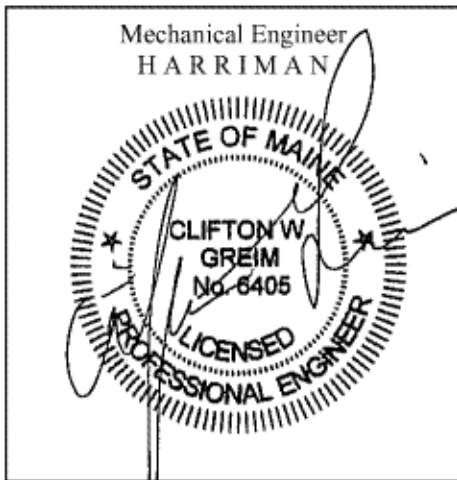
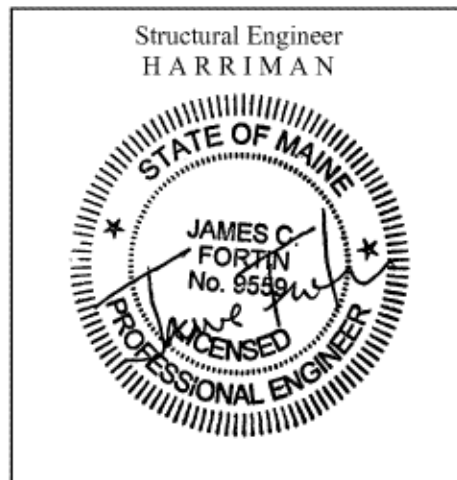
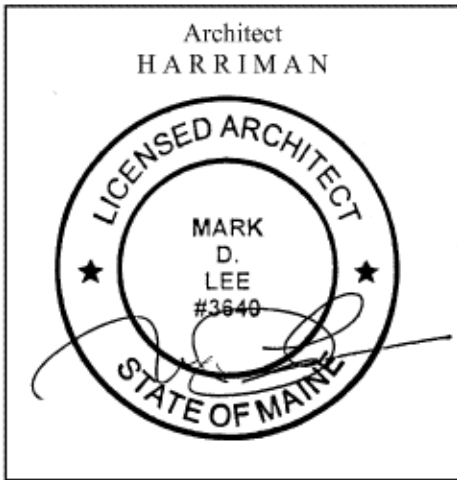
Project No. 15309

March 25, 2016

Construction Documents

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PROFESSIONAL SEAL PAGE



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JEWISH COMMUNITY ALLIANCE OF SOUTHERN MAINE

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JEWISH COMMUNITY ALLIANCE OF SOUTHERN MAINE

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SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

- A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.
- B. Related Sections:
 - 1. Section 220800 "Commissioning of Plumbing" for commissioning process activities for plumbing systems, assemblies, equipment and components.
 - 2. Section 230800 "Commissioning of HVAC" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.
 - 3. Section 260801 "Commissioning of Electrical Systems" for commissioning process activities for electrical systems, assemblies, equipment and components.

1.3 DEFINITIONS

- A. **BoD: Basis of Design.** A document that records concepts, calculations, decisions, and product selections used to meet the GPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- B. **Commissioning:** A systematic process confirming that building systems have been installed, properly started, and consistently operated in strict accordance with the Contract Documents, that all systems are complete and functioning in accordance with the Contract Documents at Substantial Completion, and that Contractor has provided Government adequate system documentation and training. Commissioning includes deferred and/or seasonal tests as approved by Government.
- C. **Commissioning Plan:** A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- D. **CxA: Commissioning Authority.**
- E. **OPR: Owner's Project Requirements.** A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

- F. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members Appointed by Owner:
 - 1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The Owner will engage the CxA under a separate contract.
 - 2. Representatives of the facility user and operation and maintenance personnel.
 - 3. Architect and engineering design professionals.
 - 4. Contracting Officer.

1.5 OWNER'S RESPONSIBILITIES

- A. Provide the OPR documentation to the CxA and Contractor for information and use.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
- C. Provide the BoD documentation, prepared by Architect to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Ensure participation and cooperation of specialty Subcontractors (including, but not limited to Mechanical, Electrical, Testing & Balancing, and Controls) as required to facilitate the commissioning process.
- B. Ensure participation of the Controls Subcontractor in demonstrating, in the presence of the Commissioning Agent, the proper sequence of operation of all equipment associated with Division 23 Section "Instrumentation and Controls for Mechanical Systems."
- C. Provide labor, material, equipment, and appurtenances, required to facilitate the commissioning process, including seasonal testing required after the initial commissioning. Perform test and verification procedures required by the commissioning process when requested by the Commissioning Agent.
- D. Review functional start-up and performance tests and documentation required by the Contract Documents and equipment manufacturers, for equipment and systems, as performed by Subcontractors and vendors.

- E. Develop schedules for testing, integrate testing into the master construction activity schedules, and coordinate Subcontractors' start-up procedures as required. Update as required.
- F. Follow manufacturer's start-up procedures and provide documentation of equipment start-up, system functional tests, and cross-system functional tests. Start-up procedures shall be in accordance with equipment manufacturer's recommendations, where applicable. Start-up procedures shall fully describe system configuration and steps required for each test, appropriately documented so that another party can repeat the procedure with virtually identical results.
- G. Submit start-up schedule, procedures, forms, and other documentation to the Commissioning Agent and the Owner for approval two months prior to starting any testing.
- H. Provide written notice to Commissioning Agent and the Owner when systems have been successfully started in accordance with manufacturer's guidelines and project document requirements and are ready for commissioning.
- I. Coordinate Subcontractors on the project specific to their responsibilities and contractual obligations.
- J. Provide engineering and technical expertise to oversee and direct the correction of deficiencies found during the commissioning process.
- K. Observe the start-up and testing of equipment by Subcontractors.
- L. Manage cross-system testing such as HVAC, building automation, fire alarm, emergency power, and life safety.
- M. Note any inconsistencies or deficiencies in system operations and enforce system compliance or recommend to the Architect modification of system design which will enhance system performance.
- N. Coordinate with the Architect/Engineer (A/E), Commissioning Agent, and Owner during commissioning final test procedures, after verifying that pretests have been satisfactorily conducted and final tests are ready to be performed.
- O. In the event that a functional test performed by or in the presence of the Commissioning Agent fails, determine the cause of failure and rectify the problem as soon as possible, and then retest. If more than two functional tests of the same system(s) are required, reimburse associated costs for the extraordinary participation of the A/E, Commissioning Agent, and Owner's staff, as required by the particular test being performed.
- P. Review operations and maintenance information and as-built drawings provided by the various Subcontractors and vendors for verification, organization and distribution.
- Q. Obtain documentation from tests and assemble a final test report to be submitted to the Architect and the Commissioning Agent for approval.
- R. As MEP systems become ready for commissioning, notify the Commissioning Agent by "signing off" on the commissioning readiness checklist, which shall be prepared by the Commissioning Agent and presented to the Contractor. Commissioning of MEP systems shall not be performed until they have been "signed off" by the Contractor.

- S. Ten month warranty, post occupancy review.
 - 1. The contractor's contract shall contain provisions for a 10-month warranty and post-occupancy review.
 - 2. The review is intended to bring the design, construction, commissioning, and facility staff together to solicit the facility staff's comments, suggestions, and areas of concern regarding the systems in the first year of operation.
 - 3. Warranties on any commissioned systems should be reviewed and deficient equipment should be identified and a plan for resolution developed.

1.7 CxA'S RESPONSIBILITIES

- A. Include CxA responsibilities in this article that have an impact on Contractor's activities and responsibilities.
- B. Organize and lead the commissioning team;
- C. Prepare a construction-phase commissioning plan;
- D. Collaborate with the Contractor and subcontractors to develop testing and inspection procedures;
- E. Coordinate commissioning activities with overall project schedule;
- F. Identify commissioning team member responsibilities by name, firm, and trade specialty, for performance of each commissioning task;
- G. Convene commissioning team meetings for the purpose of coordination, communication, conflict resolution, and to discuss the progress of the commissioning process;
- H. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals, operation and maintenance training sessions, and project completion.;
- I. Observe and inspect construction, and report progress and deficiencies. In addition to compliance with the contract documents, inspect systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.
- J. Prepare project-specific test and inspection procedures and checklists;
- K. Conduct pretest meetings of the commissioning team to review startup reports, pretest inspection results, testing procedures, testing personnel and instrumentation requirements, and manufacturers' authorized service representative services for each system, subsystem, equipment, and component to be tested;
- L. Schedule, direct, witness, and document tests, inspections, and system startups for all items listed under "systems to be commissioned" herein.
- M. Compile test data, inspection reports, and certificates, and include them in the commissioning report. Certify data of acceptance and startup for each item of equipment for start of warranty periods;

- N. Review project record documents during construction for accuracy and request revisions from
- O. Contractor to achieve accuracy;
- P. Review and comment on operation and maintenance documentation and systems manual outline for compliance with contract documents;
- Q. Verify operation and maintenance training programs;
- R. Photo construction progress for all systems;
- S. Maintain commissioning Issues Log;
- T. Prepare commissioning reports;
- U. Prepare system operating manuals (separate from O&M manuals of components) for all systems, including schematics, one-line diagrams, photographs, and narrative information;
- V. Assemble the final commissioning documentation, including the commissioning report and project record drawings.
- W. Prepare an Operation and Maintenance plan (systems manual) to assist the owner in maintaining the functional operation of the building systems.
- X. Provide post verification 10 months following construction completion. This verification shall include controls verification, general system inspection, and interview for designated facility personnel with regards to system operation.

1.8 SYSTEMS TO BE COMMISSIONED

- A. Division 07:
 - 1. Thermal Imaging for the building envelope.
- B. Division 08:
 - 1. Conduct water leakage test for the glazing elements in accordance with Division 08 requirements.
- C. Division 22:
 - 1. Chlorinating domestic water piping.
 - 2. Pressure testing for sanitary waste, vent, and storm piping.
 - 3. Pre-functional and functional testing for fuel fired domestic water heating equipment.
 - 4. Fixture general operation.
 - 5. Hot water temperature maintenance systems.
 - 6. Elevator Sump Pump.
 - 7. Above floor piping-flushing and testing inspection.
 - 8. Below slab piping inspection before pours.
 - 9. Pre-functional and functional testing for hot water recirculation pumps.
 - 10. Sanitary System – including controls, pumps, tanks.
- D. Division 23:
 - 1. Pre-functional and functional testing for Exhaust Fans.

2. Pre-functional and functional testing for Hydronic Pumps.
3. Pre-functional and functional testing for Split System Air Conditioning units.
4. Pre-functional and functional testing for Air Handling Units.
5. Pre-functional and functional testing for Hot Water Boilers and Appurtenances.
6. Gas Piping Systems.
7. Oversight for Duct Pressure Testing.
8. Functional testing for the Automatic Temperature Control System.
9. Oversight for TAB.
10. Oversight for owner training.

E. Division 26

1. Pre-functional and functional testing for Interior/Exterior Lighting and Lighting Controls System.
2. Pre-functional and functional testing for Emergency Power Systems

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 019113

SECTION 019500 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, Adjustment, and Balancing of Air Systems.
- B. Testing, Adjustment, and Balancing of Hydronic Piping Systems.
- C. Measurement of Final Operating Condition of HVAC Systems.

1.2 RELATED SECTIONS

- A. Section 014000 – Quality Requirements: Testing laboratory services: Employment of testing agency and payment for services.
- B. Section 017700 – Closeout Procedures.
- C. Division 23 – Warranty:
 - 1. TAB warranties shall conform to guidelines indicated in Division 23 with all references to Mechanical Contractor changes to TAB Contractor.

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing.
- F. IDAT – Integrated Deliverables And Testing Plan

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Design Review Reports:
 - 1. Submit prior to commencement of construction under provisions of Division 01 Section “Quality Requirements.”
 - 2. Review the Contract Documents, and indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

- C. Preliminary Report Submittals:
 - 1. Prior to commencing work of this Section, and no more than 30 days after approval of TAB Agency submittals, submit report forms or outlines indicating adjusting, balancing, and equipment data required, with columns of design data filled in. By means of plan views, equipment profiles, and similar graphical descriptions, indicate where measurements will be taken.
 - 2. Submit the procedures to be used.
- D. Field Reports: Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
- E. Provide reports in letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- F. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
- G. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, forms prepared following ASHRAE 111, or NEBB forms.

1.5 QUALITY ASSURANCE

- A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111 or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Instrument Calibration: Calibrate instruments every 6 months, or more frequently if Manufacturer requires same.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years experience and certified by AABC or NEBB, or equivalent experience which would qualify for membership in these testing organizations. Agency shall be listed under paragraph 3.1 AGENCIES in this Section.
- B. Perform Work under supervision of registered Professional Engineer experienced in performance of this Work and licensed in Maine.

1.7 SEQUENCING

- A. Sequence work under the provisions of Division 01 Section "Summary."
- B. Sequence work to commence after completion of systems or portions of work, and schedule completion of work before Substantial Completion of Project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 AGENCIES

- A. Tekon Technical Consultants, Rochester, NH. Contact: Charles Corlin, (603) 335-3080.
- B. No Substitutions.

3.2 EXAMINATION

- A. Verify that systems are complete and operating correctly in accordance with sequence of operations before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Duct systems are clean of debris.
 - 5. Fans are rotating correctly.
 - 6. Fire and volume dampers are in place and open.
 - 7. Air coil fins are cleaned and combed.
 - 8. Access doors are closed and duct end caps are in place.
 - 9. Air outlets are installed and connected.
 - 10. Duct system leakage is minimized.
 - 11. Hydronic systems are flushed, filled, and vented.
 - 12. Pumps are rotating correctly.
 - 13. Proper strainer baskets are clean and in place.
 - 14. Service and balance valves are open.
- B. Submit field reports. Report to the responsible Subcontractors, defects and deficiencies noted during performance of services which prevent system balance. Submit list of locations where the Contractor needs to provide additional balancing devices.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.4 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. For belt driven equipment, provide sheave and belt modifications and/or replacements as required to ensure design flow rates as specified.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, return air, and exhaust dampers for design conditions. Adjust at minimum position and maximum position, and use manual dampers and actuator limit stops to minimize differences.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Coordinate with Division 23 Section “Instrumentation and Controls for HVAC” for calibration of air handling units’ static pressure sensors and determination of pressure setpoints.
- M. Set pattern-control vanes and other devices in air inlets and outlets to provide the spread and throw patterns indicated, without objectionable noise or air motion to the occupants. Split the flow of linear slot diffusers in directions as required for good coverage. At completion, patterns shall be uniform and pleasing to the eye.

3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing.
- F. Where available pump capacity is less than total flow requirements of individual system parts (due to system diversity), full flow in one part may be simulated by temporary restriction of flow to other parts.
- G. Coordinate with Division 23 Section “Instrumentation and Controls for HVAC” for calibration of pump static pressure sensors and determination of pressure setpoints.
- H. When the available pump head is more than 15% above the required head to meet the design flow, trim the pump impeller to bring the head within 100 to 110 percent of the required head to meet the design flow. At least one balancing valve in the system, and one balancing valve per each multi-circuit sub-main branch served by a branch balancing valve, shall be fully open when balancing is complete.

3.8 VERIFICATION OF DUCT LEAKAGE TESTING

- A. The TAB Agent shall witness the duct leakage tests performed under Division 23 Section “Metal Ducts.” At a minimum, the first duct leakage test shall be witnessed and approved by the TAB Agent and the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the TAB Agent. The TAB Agent shall confirm proper testing procedures and shall give written approval to leakage tests. If deficiencies are discovered, the TAB Agent shall document these

deficiencies to the Contractor and the Engineer. Once deficiencies are corrected, the TAB Agent shall witness follow-up leakage tests.

3.9 COORDINATION OF SERVICES

- A. The General Contractor and his Subcontractors shall be responsible for providing the following assistance to the TAB Agent:
 - 1. Provide access to the Contractors on site ladders and man-lifts as required to allow access to required equipment by the TAB Agent.
 - 2. Keep the TAB Agent informed of the project schedule and ensure that adequate notice is given to the TAB Agent to allow for the proper testing, adjusting and balancing of mechanical systems before ceilings are flooded or access to systems is otherwise obstructed.
 - 3. Ensure that adequate time is allotted in the project schedule to allow for the proper testing, adjusting and balancing of the mechanical systems.
 - 4. Coordinate with the TAB Agent to correct system deficiencies that are discovered by the TAB Agent. Notify the TAB Agent once system deficiencies are corrected.
 - 5. Commissioning Authority shall coordinate closely with TAB Agent for necessary adjustments, etc.

3.10 PROJECT CLOSEOUT

- A. At final inspection, recheck random selections of data recorded in IDAT report. Recheck points or areas as selected and witnessed by the Architect.
 - 1. Check and adjust systems approximately six months after final acceptance and submit final IDAT report. Systems shall be rechecked and adjusted during each season.
 - 2. Retests: If random tests elicit a measured flow deviation of ten percent or more from that recorded in the certified report listings, at ten percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made.
 - 3. System shall be verified for proper performance 90 days after Owner acceptance.
- B. Provide instrument calibration reports by type used for air and water procedures and dates of last

3.11 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing to include but not be limited to:
 - 1. HVAC Pumps
 - 2. Gas Fired Boilers
 - 3. Hot Water Unit Heaters
 - 4. Radiant Floor System
 - 5. VRF Evaporators
 - 6. Heat Recovery Unit HRU-1
 - 7. Hot Water Coil HRU-1
 - 8. Exhaust fans
 - 9. Air Inlets and Outlets

B. Report Forms:

1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone number of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP
 - g. Actual flow rate, pressure drop, BHP

- h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure
7. Heating Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual
8. Air Moving Equipment:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
9. Return Air/Outside Air Data:
- a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
10. Exhaust Fan Data:
- a. Location
 - b. Manufacturer

- c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
11. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor

END OF SECTION 019500

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SECTION 029550 - SITE PREPARATION / TREE PROTECTION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all materials and equipment, and do all work required clear and grub required plants and to protect trees to be saved and transplanted along with the appropriate maintenance.

1.2 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
 - 1. Section 329300, PLANTS
 - 2. Section 024119, SELECTIVE DEMOLITION

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. International Society of Arborists, P.O. Box 3129, Champaign, IL 61826 (ISA)
 - a. Standards for Tree Transplanting
 - b. Tree Damage Penalties
 - 2. National Arborist Association, 3537 Stratford Rd., Wantagh, NY 11793 (NAA):
 - a. Pruning Standards for Shade Trees
 - b. Standard for Fertilizing Shade and Ornamental Trees

1.4 SUBMITTALS

- A. The following shall be submitted:
 - 1. Permit for transport and legal disposal of debris.
 - 2. Location plan of staging areas and schedule for moving staging equipment into those areas shall be submitted for Architect's approval prior to mobilization and related site preparation operations.
- B. Submit schedule of existing trees to be protected, pruned and fertilized and include extent of pruning and type of fertilizer application.

1.5 PROTECTION

- A. Cease operations and and notify Landscape Architect immediately if safety of adjacent structures appears to be endangered. Take precautions to properly support structures. Do not resume operations until safety is restored.
- B. Prevent movement, settlement or collapse of adjacent services, sidewalks, driveways and trees. Assume liability for such movement, settlement, or collapse. Promptly repair damage at no cost to the Owner.

- C. Provide, erect, and maintain street boardings, barricades, lighting, and guardrails as required to protect general public, workers, and adjoining property.

1.6 TREE DAMAGE PENALTIES

- A. Damages to trees, shrubs, and other vegetation deleted as to be protected and preserved will be assessed by the Arborist, Landscape Architect and Owner in accordance with the ISA Guide.

1.7 MAINTAINING TRAFFIC

- A. Do not close or obstruct roadways without permits.
- B. Conduct operations with minimum interference to public or private roadways.

PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCING

- A. Tree protection fencing shall be one of the following, at the Contractor's option.
 - 1. Wire bound woodroll snow fence of four foot minimum and six foot maximum height with 3/8 in. x 1-1/2 in. wide pickets, spaced approximately two inches apart bound together with at least 13 gauge galvanized steel wire and with brightly painted top edge.
 - 2. Polypropylene barricade fencing of four foot minimum and six foot maximum height.
- B. Stakes for fencing shall be six foot steel or wood posts for tree protection fence four foot in height and eight foot steel or wood posts for tree protection fence six foot in height. Posts shall be spaced eight foot o.c. maximum.
- C. Tree protection fence is not to be substituted for construction security fencing.

PART 3 - EXECUTION

3.1 PROTECTION OF EXISTING TREES AND SHRUBS

- A. Existing trees and shrubs that are indicated on the Drawings as to remain shall be suitably protected prior to site demolition, clearing and grubbing operations and during the life of the Contract. Particular attention should be paid to mature trees along Congress Street. Such trees and shrubs that are injured due to Contractor's operations to such a degree that, in the opinion of the Landscape Architect, their usefulness or appearance are significantly impaired, shall be assessed by the Landscape Architect and Owner in accordance with the ISA Guide, and replaced at the Contractor's expense.
- B. Materials shall not be stored and equipment shall not be operated under the branches of existing trees that are to remain, except in areas approved by the Landscape Architect.
- C. Tree protection fencing shall be provided at the drip line to protect existing trees from damage during construction. The contractor may also utilize a measurement system of 1.25 feet per

every inch of trunk diameter with a minimum of a six foot radius to the tree protection fencing if the tree trunk has a caliper smaller than four inches.

- D. In the event the tree protection fencing becomes an obstruction to construction, the contractor may then substitute the fencing, in an area approved by the Landscape Architect, with an eight inch thick layer of organic mulch to protect existing soil drying out and compaction. The tree trunks shall also be protected with a wrap barrier.

3.2 CLEARING AND GRUBBING

- A. Contactor shall confirm with the Landscape Architect all trees and shrubs to remain and to be removed within the project area with a focus on existing plant material near or adjacent to building entrances.
- B. Trees, shrubs, and other vegetation not indicated on the Drawings or designated in the field by the Landscape Architect to remain or be transplanted and required for execution of the Work shall be cleared and grubbed.
- C. Stumps shall be removed to their full depth. Roots three inches and larger shall be removed to a depth of two feet below finished grade. Stumps shall be legally disposed of off-site.

3.3 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

- A. Existing structures and utilities shall be suitably protected from damage.

3.4 SALVAGEABLE MATERIALS

- A. Materials indicated on the Drawings or designated by the Landscape Architect in the field to be salvaged shall be carefully removed, protected from damage, and put in temporary storage. Acceptable storage location(s) shall be as directed by the Owner.

3.5 TREE PRUNING

- A. Pruning of existing trees shall be "Class II Medium Pruning" conforming to NAA Ref. 1.

3.6 FERTILIZATION

- A. Fertilizing existing shade and ornamental trees shall conform to NAA Ref. 2.

3.7 DISPOSAL OF MATERIALS

- A. Material resulting from the site preparation work and not scheduled to be salvaged and which is unsuitable for reuse on the project, shall become the property of the Contractor and shall be legally disposed of off-site.
- B. Debris, rubbish, and other material shall be disposed of promptly and shall not be left until final cleanup of site.

END OF SECTION 029550

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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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Suspended slabs.
 - 5. Exterior concrete slabs and walks.
 - 6. Reinforcement grid to support radiant heat piping.
- B. Related Sections include the following:
 - 1. Division 03 Section "Concrete Sealer" for clear sealer to be applied to interior concrete slabs left exposed.
 - 2. Division 07 Section "Building Insulation" for composite insulation under slabs-on-grade, including slabs receiving radiant heat.
 - 3. Division 07 Section "Under-Slab Vapor Retarders" for vapor retarders under slabs-on-grade, including slabs receiving radiant heat.
 - 4. Division 23 Section "Radiant-Heating Hydronic Piping" for attachment of radiant heat piping to reinforcement grid.
 - 5. Divisions 31, 32 and 33 Sections for drainage fill under slabs-on-grade.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Include special reinforcing required for openings through concrete structures.
- D. Submit locations for construction and control joint layout for walls, slabs and exterior flatwork and walks.

- E. Qualification Data: For ACI certified flatwork finisher certificate.
- F. Submit for record, a written plan of the field procedures to be implemented for hot and cold weather protection.
- G. Submit chart for application requirements of evaporation control.
- H. Minutes of pre-concrete conference and pre-concrete slab conference.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications - Slabs: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and an onsite supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Pre-Concrete Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Review requirements of submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Agency responsible for concrete design mixtures.
 - c. Agency responsible for field quality control.
 - d. Ready-mix concrete manufacturer.
 - e. Concrete subcontractor.

- f. Architect.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, steel reinforcement installation, and concrete protection.
- G. Pre-Concrete Slab Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
- 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Review requirements of submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Agency responsible for concrete design mixtures.
 - c. Agency responsible for field quality control.
 - d. Ready-mix concrete manufacturer.
 - e. ACI Certified Concrete Flatwork Finisher, including ACI Certified field foreman.
 - f. Architect.
 - g. Concrete flatwork subcontractor.
 - h. Radiant-heating hydronic piping subcontractor.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, vapor-retarder installation coordination, under slab insulation installation coordination, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete protection, and protection of radiant-heating hydronic piping.
 - 3. Review floor trowel finish requirements specified in Article 3.8, test area location, and coordination for review by all parties.
- H. Allow concrete slabs receiving athletic flooring, and thin-set ceramic and quarry tile to cure for 120 days minimum before the installation of floor systems.
- I. Construct a mock-up of exterior concrete flatwork and sidewalk, demonstrating slab flatness, finish, and saw cut joints. Coordinate location with the Architect. Sample found acceptable may remain as part of the work. Rejected samples shall be removed.

1.5 PROJECT CONDITIONS

- A. To prevent exterior concrete entrance slabs, pavement and walks from repeated freeze thaw cycles and deicers before adequate curing to protect concrete has occurred, placement shall occur before October 1 or in the Spring after frost in the ground is gone and temperatures remain above freezing. No deicers shall be used on the concrete during the project.

1.6 FOUNDATION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly in writing.

- B. General: Engage an engineering surveyor to lay out the Work using accepted surveying practices.
 - 1. Work from establish benchmarks and control points to set lines and levels.
 - 2. Inform installers of lines and levels to which they must comply.
 - 3. Check the location, level and plumb, of every major element as the Work progresses.
 - 4. Notify Construction Manager and Architect when deviations from required lines and levels exceed allowable tolerances.
 - 5. Coordinate and locate anchor bolt layouts.
 - 6. Coordinate elevation and locations of openings, bondouts, sleeves and inserts required to be placed in the work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

- E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 1/2 by 1/2 inch, minimum.
- F. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Comply with State of Maine DEP regulations for VOC content of not more than 450 g/L. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- G. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.
- C. Plain-Steel Wire: ASTM A 82, as drawn.
- D. Deformed-Steel Wire: ASTM A 496.
- E. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Slab Construction Joint Dowels:
 - 1. PNA Diamond Dowel System, PNA Construction Technologies; pna-inc.com.
 - a. Load Plates: Saw cut from hot rolled plate per ASTM A36, 1/4-inch thick by 4-1/2-inch square.
 - b. Pocket Former: High-density plastic pocket former with nailing fins for attachment to edge forms.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I or II, gray.
 - a. Supplementary Cementitious Materials (Permitted for Footings and Walls Only):
 - 1) Ground Granulated Blast-Furnace Slag, ASTM C 989, Grade 100 or 120. Limit the amount of ground granulated blast-furnace slag ash as a percentage of cementitious materials to 40%.
 - 2) Fly Ash: ASTM C 618, Class F. Limit the amount of fly ash as a percentage of cementitious materials to 30%.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: #57 gradation (nominal size 1-inch to No. 4).
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A or Type F.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.7 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 3/4 inches long.
 - 1. Products:
 - a. Monofilament Fibers:
 - 1) Grace Construction Products, W. R. Grace & Co.; Grace MicroFiber.

2.8 CURING AND SEALING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Products:
 - a. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.

- b. Dayton Superior Corporation; Sure Film.
- c. Euclid Chemical Company (The); Eucobar.
- d. L&M Construction Chemicals, Inc.; E-Con.
- e. MBT Protection and Repair, Div. of ChemRex; Confilm.
- f. Meadows, W. R., Inc.; Sealtight Evapre.
- g. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
- h. Sika Corporation, Inc.; SikaFilm.
- i. Symons Corporation, a Dayton Superior Company; Finishing Aid.
- j. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

- B. Moisture-Retaining Cover: ASTM C 171, white polyethylene film or white burlap-polyethylene sheet.
- C. Exterior Concrete Flatwork Sealer: Water-based silane/siloxane water repellent and chloride screen.
 - 1. Prosoco Consolideck Saltguard WB.
- D. Water: Potable.

2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D3575, 1.7 pound minimum density closed cell polyethylene with 1/2-inch deep top strip-off edge to allow installation of joint sealant; 1/2-inch thickness by full depth of slab.
 - 1. A.H. Harris; Harristrip-Off; Harris Polyethylene Joint Filler.
 - 2. Foam Peel HT; Foamtastic, division of Hohmann & Barnard ~~or accepted equivalent.~~
 - 3. W.R. Meadows; Deck-O-Foam.
- B. Joint-Filler Strips Left Exposed: ASTM D 1751, asphalt-saturated cellulosic fiber.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Joint Sealant: Single-component pourable urethane sealant, Class 25.
 - 1. Products:
 - a. Sika Corporation, Inc.; Sikaflex - 1CSL.
 - b. Sonneborn, Division of ChemRex Inc.; SL 1.

2.10 REPAIR MATERIALS

- A. Repair Underlayment (To Receive Resilient Floor Covering): Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.

4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Admixtures: Use admixtures according to manufacturer's written instructions.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Foundation Walls and Footings: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength:
 - a. 3000 psi at 28 days, unless indicated otherwise.
 2. Maximum Water-Cementitious Materials Ratio: 0.54.
 3. Slump Limit: 4 inches, plus or minus 1-1/2 inches.
 - a. 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery
- B. Interior Slabs: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength: 3000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.52.
 3. Slump Limit: 4 inches, plus or minus 1-1/2 inches.
 - a. Slump for pumped concrete may be increased to compensate for slump loss in the hose by adding high-range water-reducing admixture or plasticizing admixture. Slump at the point of hose discharge shall not exceed 5-1/2 inches.
 4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent. Entrapped air only, do not add air-entraining admixture.
 5. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.
 - a. Fiber not required for slabs reinforced with reinforcing bars.
 6. Fly ash and slag cementitious materials are not permitted for slabs.
- C. Exterior Slabs and Walks: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength: 4000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.44.
 3. Slump Limit: 4 inches, plus or minus 1-1/2 inches.
 4. Air Content: 6.5 percent, plus or minus 1 percent at point of delivery.

2.13 FABRICATING REINFORCEMENT

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

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, and furnish batch ticket information. Include on batch ticket the amount of water introduced into the mix at the plant, and amount of water that can be added later, and stay within the specified water-cementitious materials ratio.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class C, 1/2 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Do not use rust-stained steel form-facing material for exposed surfaces.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not weld reinforcing bars.
 - 1. Provide reinforcing over vapor retarder under slabs-on-grade receiving radiant heat attachment. Coordinate spacing of reinforcing bars with requirements of radiant-heating hydronic piping.

2. Coordinate depth of reinforcing and radiant heat hydronic piping to assure height is kept below slab saw cut depth.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Reinforce stair pans with strips of 3 inch by 6 inch #10 wire mesh or two layers 6 inch by 6 inch #10 mesh overlapped, full width and depth of pan.

3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction (Control) Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, with a one inch minimum, as follows:
1. Sawed Joints: Form contraction joints with Soff-Cut early-entry dry-cut control joint saw cutting. Install cuts at each control joint location as soon as concrete will support weight of saw and operator without disturbing final finish. Provide adequate equipment to complete cutting operations within 2 hours after final pass of trowel. Use Soff-Cut blades and skid plates, using a new skid plate with each new blade. Remove debris in path of cut and under skid plate before cutting. Install Soff-Cut joint protector at saw-cut intersection prior to cross-cut. Remove dry powder saw cut concrete spoils immediately without disturbing finish.
 2. Joint Width: 1/8-inch for slabs to receive floor coverings. 1/4-inch for joints to be left exposed and filled with joint sealant.
 3. Contraction joints shall be placed in accordance with approved Shop Drawings. The panel shall be as nearly square as possible. If panel cannot be square, do not exceed panel length to panel width ratio of 1 to 1-1/2. Conform to bay spacing wherever possible (at column centerlines, half bays, third bays, one quarter bays, or equal division to meet the specified spacing requirements).

4. Make initial saw cut at mid-length of slab and proceed by saw-cutting at mid-length of each subsequent panel until all joints have been cut.
 5. Joints are not permitted in slabs of coolers or freezers.
 6. Avoid traffic across saw cut until sufficient strength is gained to protect joint edges.
 7. Saw cut slabs on grade in accordance with spacing indicated. Where not indicated, saw cut in accordance with the following maximum spacing:
 - a. 4 inches thick slab: 8 feet.
 - b. 5 to 6 inches thick: 10 feet.
 - c. 6 1/4 to 7 inches thick: 12 feet.
 - d. 7 1/4 to 8 inches thick: 14 feet.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Slab Joints: Install plate system and support assemblies at construction joints and joints where indicated.
- F. Joints in Sidewalks and Exterior Flatwork: Radius edges of walks and outside edges of slabs with 1/4-inch radius edge tool.
1. Saw cut joints, complying with contraction joint cutting requirements, unless indicated otherwise. Submit shop drawing of saw cut layout for approval.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
1. Provide protection of radiant-heating hydronic piping from damage and displacement during placement of concrete slabs.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect. Record water added at the Project site on batch ticket.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6

inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.

- G. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to view.

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

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

3.8 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. If pan floats are used, the first floating shall be done by power trowel with conventional float blades to open surface to allow release of bleed water and prevent blistering. Restraighten, cut down high spots, and fill low spots as required to meet the floor flatness and levelness tolerances. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces to receive trowel finish.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a smooth trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, paint, or another thin-film-finish coating system.
 - a. Trowel finish shall provide a smooth, uniform surface, with no ridges or swirl marks that would telegraph through floor coverings. Do not trowel to a shiny burnish surface. The intent is to provide a smooth even floor while leaving the surface texture open enough to permit drying of the slab to achieve required moisture content for floor covering installation.
 - 1) Provide a trowel finish test area and review surface finish with floor covering subcontractors.
 - 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
 - b. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
 - c. Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24; for gymnasium Multi-Purpose resilient athletic floor.
 - 3. Where floor drains occur, water test the slab in the presence of the Architect to confirm proper slope to drains without high and low areas that cause ponding and bird baths. Grind high spots to permit drainage.
- D. Exterior Concrete Walks and Flatwork: Place concrete, screed and wood float surfaces to a smooth and uniform finish, free of open texturing and exposed aggregate. Avoid working bleed water into surface mortar.
 - 1. Bull float directly behind screed before bleedwater appears. If bleed water appears, do not work bleed water into surface, allow it to evaporate.
 - 2. Immediately behind bullfloat, drag broom across surface for a light broom finish if surface paste provides adequate stiffness to maintain acceptable surface texture. If bleedwater appears before application of broom finish, allow surface water to evaporate before brooming.
 - 3. Coordinate required final broom finish with Architect before application.

4. Walks and slabs shall be flat at no greater than plus or minus 1/4 inch in 10 feet. Walks and slabs shall pitch to permit drainage, free of ponding water.

3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, 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 indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations sloped to detail.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.10 CONCRETE PROTECTING AND CURING AND SEALING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete slab surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 1. Moisture-Retaining-Cover Curing (Slabs receiving floor coverings, sealer, exterior walks and exterior slabs): Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Do not add water to surface of interior concrete slabs before covering.
 2. Concrete shall remain above 40°F for a minimum of 28 days to permit proper curing.

3.11 EXTERIOR CONCRETE FLATWORK SEALER

- A. Exterior Concrete Flatwork Sealer: Apply sealer to all exterior horizontal surfaces including, walks, entrance slabs, plazas, landings, concrete steps and ramps.
 - 1. Allow concrete to dry for a minimum of 14 days after moisture retaining curing methods are removed.
 - 2. Concrete surface and air temperatures during application and for at least 8 hours following shall be above 40°F.
 - 3. Apply sealer to clean dry surface in accordance with manufacturer's application instructions. Keep surface wet with sealer to permit penetration. Broom out puddles thoroughly until all sealer has penetrated the surface.

3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler to joints left exposed, according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged to the maximum extent possible, but not less than four months. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Provide backer material to provide joint depth to width ratio required by sealant manufacturer.
- D. 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.
- E. Concrete slabs shall be dry. Slab temperature shall be 45°F minimum and rising.
- F. Allow 3-day sealant cure time before foot traffic and 7 days before full service use.

3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Formed Surfaces Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area 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.
 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas 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.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Steel reinforcement placement.
 2. Headed bolts and studs.
 3. Verification of use of required design mixture.

4. Concrete placement, including conveying and depositing.
 5. Curing procedures and maintenance of curing temperature.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - b. 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.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Field-Cured Cylinders: For cold weather concrete operations, where and when directed by the Architect, prepare an additional set of four standard cylinders to be cured at the site, maintaining cylinders in the conditions and at the temperature of the in-place concrete. Provide cure box with temperature recorder. Protect field cylinders from being hit, damaged, and from vibration during initial set.
 - c. Properly store cylinders while awaiting transport to laboratory, maintaining temperature between 60 deg F and 80 deg F. Deliver to laboratory for curing within 24 hours of casting test specimen.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive

strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

- D. If directed by the Owner, the Owner's testing agent will measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION 033000

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SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

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 precast architectural concrete units including, but not limited to, the following:
 - 1. Precast architectural concrete units.
- B. Related Sections include the following:
 - 1. Division 04 Section "Unit Masonry Assemblies" for full-size brick facing, mortar, and anchorages.
 - 2.
 - 3. Division 07 Section "Joint Sealants" for elastomeric joint sealants and sealant backings.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Design Mixes: For each concrete mix.
- D. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication and installation of precast architectural concrete units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, limits of each finish, types of reinforcement, including special reinforcement, and layout of anchorage devices. Include locations and details of hoisting points and lifting devices for handling and erection.
 - 1. Indicate locations and details of anchorage devices to be embedded in other construction.
- E. Samples: For each type of finish indicated on exposed surfaces of precast architectural concrete units, in sets of 3, illustrating full range of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced Installer who has completed precast architectural concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

- B. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast architectural concrete units similar to those indicated for this Project and with a record of successful in-service performance.
 - 1. Participates in PCI's Plant Certification program and is designated a PCI-certified plant for Group A, Category A1--Architectural Cladding and Load Bearing Units or in APA's Plant Certification Program for Production of Architectural Precast Concrete Products and is designated an APA-certified plant.
 - 2. Has sufficient production capacity to produce required units without delaying the Work.
- C. Design Standards: Comply with ACI 318 and the design recommendations of PCI MNL 120, "PCI Design Handbook--Precast and Prestressed Concrete."
- D. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
- E. Mockups: Before installing precast architectural concrete units, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work.
 - 1. Obtain Architect's approval of mockups before starting fabrication.
 - 2. In presence of Architect, damage part of an exposed face for each finish, color, and texture, and demonstrate materials and techniques proposed for repairs to match adjacent undamaged surfaces.
 - 3. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 4. Demolish and remove mockups when directed.
 - 5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver precast architectural concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, chipping, distorting, warping, staining, or other physical damage, and so markings are visible during storage.
 - 1. Prevent staining and discoloration of stacked units during storage. Replace units or clean and obtain Architect's approval before installation. Replace units that cannot be cleaned to Architect's approval.
- B. Place stored units so identification marks are clearly visible, and units can be inspected.
- C. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses, which would cause cracking, damage, or chipping of corners and edges.
- D. Lift and support units only at designated lifting and supporting points as shown on Shop Drawings.

1.6 SEQUENCING

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fabricators:
 - 1. Northern Design Precast Inc., Guilford, NH; contact: Jesse Thompson; website: www.ndprecast.com; phone: (603) 783-8989.
 - 2. MGA Cast Stone, Inc., Oxford, ME; contact: Greg Hamann; e-mail: greg@mgacaststone.com; phone: (207) 539-6035.

2.2 MOLD MATERIALS

- A. Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood, or another material that is nonreactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes.

2.3 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from galvanized steel wire into flat sheets.

2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type III, gray, of same type, brand, and source throughout Project.
- B. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S.
 - 1. Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining.
 - a. Gradation: Uniformly graded to match design reference sample.
 - 2. Fine Aggregates: Selected, natural or manufactured sand of the same material as coarse aggregate, unless otherwise approved by Architect.
- C. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
- D. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

- E. Water-Reducing Admixture: ASTM C 494, Type A.
- F. Retarding Admixture: ASTM C 494, Type B.
- G. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- H. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

2.5 STAINLESS STEEL CONNECTION MATERIALS

- A. Stainless Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
- B. Stainless Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless steel nuts; and flat, stainless steel washers.

2.6 SETTING MATERIALS

- A. Mortar: Type S mortar meeting the requirements of Division 04 Section "Unit Masonry Assemblies."
 - 1. Color: Coordinate with adjacent face brick.

2.7 CONCRETE MIXES

- A. Prepare design mixes for each type of concrete required.
- B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast architectural concrete fabricator's option.
- C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318.
- D. Normal-Weight Concrete Face: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 5000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
- E. Water Absorption: 12 to 14 percent by volume, tested according to PCI MNL 117.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content complying with PCI MNL 117.
- G. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

2.8 MOLD FABRICATION

- A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing operations.

- B. Maintain molds to provide completed precast architectural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
 - 1. Edge and Corner Treatment: Uniformly chamfered.

2.9 FABRICATION

- A. Furnish loose dowels, cramps, hangers, and other hardware shapes for securing precast architectural concrete units to supporting and adjacent construction.
- B. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" and PCI MNL 117 for fabricating, placing, and supporting reinforcement.
 - 1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
 - 2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
 - 3. Place reinforcement to maintain at least 3/4-inch minimum coverage. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
 - 4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- C. Reinforce precast architectural concrete units to resist handling, transportation, and erection stresses.
- D. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.
- E. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 117 for measuring, mixing, transporting, and placing concrete.
- F. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 117.
- G. Comply with ACI 306.1 procedures for cold-weather concrete placement.
- H. Comply with ACI 305R recommendations for hot-weather concrete placement.
- I. Identify pickup points of precast architectural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast architectural concrete unit on a surface that will not show in finished structure.
- J. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

- K. Discard precast architectural concrete units that are warped, cracked, broken, spalled, stained, or otherwise defective unless repairs, made in a manner that complies with specification requirements, are approved by Architect.

2.10 FABRICATION TOLERANCES

- A. Fabricate precast architectural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.
- B. Fabricate precast architectural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with the following product tolerances:
 - 1. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:
 - a. 10 feet or under, plus or minus 1/8 inch.
 - 2. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:
 - a. 10 feet or under, plus or minus 1/4 inch.
 - 3. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches or 1/2 inch total, whichever is greater.
 - 4. Bowing: Plus or minus $L/360$, maximum 1 inch.
 - 5. Local Smoothness: 1/4 inch per 10 feet.
 - 6. Warping: 1/16 inch per 12 inches of distance from the nearest adjacent corner.
- C. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.
 - 1. Inserts: Plus or minus 1/2 inch.
 - 2. Handling Devices: Plus or minus 3 inches.
 - 3. Reinforcing Steel and Welded Wire Fabric: Plus or minus 1/4 inch where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch.

2.11 FINISHES

- A. Finish exposed-face surfaces of precast architectural concrete units as follows:
 - 1. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
 - a. Provide light sandblast finish.
 - b. Color: Match face brick veneer type 1A: Glen-Gery, Sunset S15.
- B. Finish exposed top, bottom, and back surfaces of precast architectural concrete units to match face-surface finish.
- C. Finish unexposed surfaces of precast architectural concrete units by float finish.

2.12 SOURCE QUALITY CONTROL

- A. Owner may employ an independent testing agency to evaluate precast architectural concrete fabricator's quality-control and testing methods.
 - 1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.
- B. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements.
- C. Strength of precast concrete units will be considered deficient if units fail to comply with ACI 318 requirements.
- D. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- E. Defective Work: Precast architectural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Inspect precast units for chips and discoloration in presence of Architect before installation. Replace units found to be unacceptable.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Do not install precast concrete units until supporting concrete has attained minimum design compressive strength.

3.2 INSTALLATION

- A. Install clips, hangers, and other accessories required for connecting precast architectural concrete units to supporting members and backup materials.
- B. Flashing, air/vapor barriers, and insulation shall be installed behind precast architectural concrete units in accordance with Division 04 Section "Unit Masonry Assemblies" and Division 07 Section "Fluid-Applied Air/Vapor Barrier System."

- C. Install precast architectural concrete units plumb, level, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.
 - 1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 - 2. Remove projecting hoisting devices and use mortar to fill voids within recessed hoisting devices flush with surface of concrete.
- D. Anchor precast architectural concrete units in position using stainless steel anchors according to approved Shop Drawings.
- E. Completely seal around anchor pins on lintel angles that penetrate flashing with bituminous flashing and elastomeric sealant. Remove temporary shims, wedges, and spacers as soon as possible after anchoring and mortar operations are completed.
- F. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders.
 - 1. Protect precast architectural concrete units from damage by field welding or cutting operations and provide noncombustible shields as required.
 - 2. Repair damaged steel surfaces by cleaning and applying a coat of galvanizing repair paint to galvanized surfaces.
- G. Mortar Placement: Pack joints with stiff mortar material, tamping until voids are completely filled. Keep filled joints damp for not less than 24 hours after initial set. Promptly remove mortar material from exposed surfaces before it affects finishes or hardens.
 - 1. Rake out joints to a depth of 3/4-inch to allow installation of backer rod and sealant specified as work of Division 07 Section "Joint Sealants."

3.3 ERECTION TOLERANCES

- A. Install precast architectural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

3.4 REPAIRS

- A. Repair exposed exterior surfaces of precast architectural concrete units to match color, texture, and uniformity of surrounding precast architectural concrete, made in a manner that complies with specification requirements, if permitted by Architect.
- B. Remove and replace damaged precast architectural concrete units if repairs do not comply with requirements.

3.5 CLEANING

- A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.
 - 1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END OF SECTION 034500

SECTION 042000 - UNIT MASONRY ASSEMBLIES

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 unit masonry assemblies consisting of the following:
 - 1. Face brick.
 - 2. Mortar and grout.
 - 3. Masonry joint reinforcement.
 - 4. Ties and anchors.
 - 5. Embedded flashing.
 - 6. Miscellaneous masonry accessories.
 - 7. Veneer-wall insulation.
 - 8. Masonry waste disposal.
- B. Related Sections include the following:
 - 1. Division 03 Section "Plant-Precast Architectural Concrete."
 - 2. Division 04 Section "Stone Masonry."
 - 3. Division 05 Section "Structural Steel Framing" for steel relieving angles attached to structural steel.
 - 4. Division 07 Section "Fluid-Applied Air/Vapor Barrier System" for air/vapor barrier system.
 - 5. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
 - 6. Division 07 Sections "Penetration Firestopping" for firestopping at openings in masonry walls and "Fire Resistive Joint Systems" for firestopping joints at fire-rated masonry walls.
 - 7. Division 07 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.
 - 8. Division 32 Sections for unit pavers.
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels for unit masonry, furnished under Division 05 Section "Metal Fabrications."
 - 2. Counterflashing in masonry joints for metal flashing, furnished under Division 07 Section "Sheet Metal Flashing and Trim."

1.3 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional structural engineer, as defined in Division 01 Section "Quality Requirements," to design layout and spacing of masonry veneer anchors.

- B. Design Wind Pressures for Wall Components:
 - 1. Corner Pressures: +19 lbf/sq. ft. and -23 lbf/sq. ft.
 - 2. Field-of-Building Pressures: +19 lbf/sq. ft. and -21 lbf/sq. ft.

1.5 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- D. Delegated-Design Data for Masonry Veneer Anchors: For masonry veneer anchors indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Samples for Initial Selection: For the following:
 - 1. Weep holes/vents showing colors available.
- F. Samples for Verification: For each type and color of the following:
 - 1. For each color and texture of face brick, in the form of straps of five or more bricks.
- G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- H. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
 - 1. Masonry Units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 - c. For masonry units used in fire-rated assemblies, provide certificate establishing fire-resistance rating of units.
 - 2. Cementitious materials. Include brand, type, and name of manufacturer.
 - 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 4. Grout mixes. Include description of type and proportions of ingredients.
 - 5. Reinforcing bars.
 - 6. Joint reinforcement.
 - 7. Anchors, ties, and metal accessories.
- I. Submit samples of sand to an approved laboratory for tests. Submit test report for approval.
- J. Cold- and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.
- K. Installation Inspection Report: Submit report of completed work inspection, for each area that is completed and ready to turn over for application of the air/vapor barrier system.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this Section with minimum 5 years experience.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
- E. Mockups: Build mockup panels to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution with each trade providing components of their work.
 - 1. Prepare mockups for review at Preinstallation Conference.
 - 2. Exterior Framed Wall Mockup: Provide masonry veneer mockup on one leg of exterior framed wall mockup constructed in Division 05 Section "Cold-Formed Metal Framing" as follows:
 - a. Include cavity insulation and veneer anchors and ties at same spacing as specified.
 - b. Install Brick Veneer above precast architectural concrete band provided in Division 03 Section "Plant-Precast Architectural Concrete."
 - c. Include a sealant-filled joint at least 16 inches long in masonry mockup.
 - d. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing). Include counterflashing necessary at top edge of air/vapor barrier.
 - 3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 - 4. Protect accepted mockups from the elements with weather-resistant membrane. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
 - 6. Demolish and remove mockups when directed by Architect.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Parties that shall be present shall include the Owner, Architect, masonry subcontractor, masonry subcontractor's field superintendent and field workers performing the actual

application, air/vapor barrier applicator, and installers whose work interfaces with or affects unit masonry assemblies, including but not limited to installers of storefront, curtain wall, and doors.

2. Review mockup.
3. Review tooling requirements for masonry receiving air/vapor barrier membrane.
4. Review procedures and installation requirements of flexible and metal flashings.
5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
6. Provide 5 business days minimum advance notice to participants prior to convening preinstallation conference.

G. Installation Inspection: Contractor and Installer shall inspect completed masonry backup installation for compliance with installation specifications and details and submit a report for each area that is completed and ready to turn over for application of the air/vapor barrier system. Report shall include the following:

1. Verify masonry joints are completely filled and free of voids and lumps.
2. Verify masonry joints are tooled slightly concave.
3. Verify that masonry reinforcing with pintels is at the specified spacing.
4. Verify that masonry pintels are free of mortar droppings.
5. Verify foundation ledge is clean and free of mortar droppings.
6. Verify through wall flashings are installed at specified locations.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
- F. Protect plastic insulation as follows:
 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 2. Store insulation on pallets of blocking not less than 4 inches above grade. Insulation stored directly on ground may void insulation warranty.
 3. Protect insulation with a waterproof covering, and ventilate to avoid condensation. Wrapping materials used for shipping are not adequate for weather protection at job site.
 4. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.

5. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
6. Maintain in dry condition. Do not install wet insulation within exterior wall assemblies.
7. Do not install damaged insulation.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 and the following:
 1. Cold-Weather Construction: When the ambient temperature is within the limits indicated, use the following procedures:
 - a. 40 to 32 deg F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg F.
 - b. 32 to 25 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry.
 - c. 25 to 20 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F if grouting. Use heat on both sides of walls under construction.
 - d. 20 deg F and Below: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F. Provide enclosures and use heat on both sides of walls under construction to maintain temperatures above 32 deg F within the enclosures.

2. Cold-Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection, this is in addition to construction procedures specified above:
 - a. 40 to 25 deg F: Cover masonry insulating blankets for 48 hours after construction.
 - b. 25 deg F and Below: Provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 72 hours after construction.
 3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
1. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Products: Subject to compliance with requirements, provide one of the products specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 BRICK

- A. General: Provide shapes indicated and as follows for each form of brick required:
1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 3. Provide special shapes as indicated and for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

- B. Face Brick: ASTM C 216, Grade SW, Type FBS.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of not less than 8000 psi.
 - 2. Initial Rate of Absorption: Less than 18 g/30 sq. in. per minute when tested per ASTM C 67.
 - 3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 - 4. Size (Actual Dimensions):
 - a. Brick Veneer: 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
 - b. Special shapes shall have dimensions indicated.
 - 5. Application: Use where brick is exposed, unless otherwise indicated.
 - 6. Color and Texture: As indicated.

- C. Building (Common) Brick: ASTM C 62, Grade SW.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of not less than 8000 psi.
 - 2. Size: Match size of face brick.
 - 3. Application: Use where brick is indicated for concealed locations.

2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

- B. Hydrated Lime: ASTM C 207, Type S.

- C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S. Standard masonry cement is not acceptable. Provide one of the following portland cement-lime mix products:
 - 1. Eaglebond; Lafarge North America Inc.
 - 2. Portland and lime; Cement Quebec, Inc.
 - 3. Portland and lime Quikrete; The Quikrete Companies.

- D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar. Pigmented mortar used
 - 1. Products: Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.
 - a. Colors for pigmented mortar as selected by Architect from manufacturer's full range of options.
 - b. Pigmented mortar used with Brick Veneer.

- E. Aggregate for Mortar: ASTM C 144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand.

- F. Aggregate for Grout: ASTM C 404.

- G. Water: Potable.

2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

2.6 MASONRY JOINT REINFORCEMENT

- A. Masonry Joint Reinforcement, General: ASTM A 951.
 - 1. Interior Walls: Hot-dip galvanized, carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 - 3. Wire Size for Side Rods - Exterior Walls: W2.8 or 0.188-inch diameter.
 - 4. Wire Size for Side Rods - Interior Walls: W1.7 or 0.148-inch diameter.
 - 5. Wire Size for Cross Rods: W1.7 or 0.148-inch diameter.
 - 6. Wire Size for Veneer Ties: W1.7 or 0.148-inch diameter.
 - 7. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 - 8. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.7 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with eight subparagraphs below, unless otherwise indicated.
 - 1. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 or 316.
 - 2. Stainless-Steel Sheet: ASTM A 666, Type 304.
 - 3. Stainless Steel Bars: ASTM A 276 or ASTM A 666, Type 304.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Adjustable Masonry-Veneer Anchors:
 - 1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to metal studs and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
 - 2. Screw-Attached, Masonry-Veneer Anchors with Weather-Resistant Gypsum Sheathing and Insulation: Units consisting of a wire tie and an adjustable metal anchor section.
 - a. Anchor Section: Dual-diameter stainless steel barrel section with thermal-plastic wing nut and metal backed neoprene washer, and corrosion-resistant, self-drilling screw. Barrel length to suit sheathing thickness and insulation thickness.
 - b. Wire Ties: Triangular-shaped wire ties fabricated from 0.188-inch- diameter, adjustable, stainless steel wire.
 - c. Product: Hohmann & Barnard, Inc.; Thermal 2-Seal Wing Nut Tie with 2X-Hook Tie.

2.8 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual, Division 07 Section "Sheet Metal Flashing and Trim," and as follows:

1. Tin-Zinc Alloy Coated Copper: Temper H00 or H01, cold-rolled copper sheet, 16-oz./sq. ft. weight or 0.0216 inch thick, coated with tin-zinc alloy and a protective washcoat.
 - a. Product: FreedomGray; Revere Copper Products, Inc.
 2. Fabrication: Form metal flashing to required shape using sheet metal break.
 - a. Fabricate metal flashing with drip edge. Fabricate by extending flashing 3/8 inch out from wall, with outer edge bent down 45 degrees.
 - 1) Lintel head flashings shall be fabricated with ends turned up and inside corners soldered. Metal flashing shall extend horizontally across lintel angle, up the vertical leg, and across the cavity to support the flexible flashing tie-in to the air/vapor barrier.
- B. Flexible Flashing: For flashing not exposed to the exterior, use the following, unless otherwise indicated:
1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
 - a. Coordinate flashing and mastic with manufacturer of air/vapor barrier system. If proposed flashing system is not from the air/vapor barrier manufacturer being used on the project, it is the responsibility of the mason contractor to obtain and submit a statement of compatibility from the air/vapor barrier system being used on the project.
 - b. Products:
 - 1) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
 - a) Termination Mastic: CCW-704 rubberized bitumen mastic. Coordinate mastic and flashing with manufacturer of air/vapor barrier system.
 - 2) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
 - a) Termination Mastic: Bituthene Mastic. Coordinate mastic and flashing with manufacturer of air/vapor barrier system.
 - 3) Henry Company; Blueskin TWF Thru-Wall Flashing.
 - a) Termination Mastic: Polybitume 579-05. Coordinate mastic and flashing with manufacturer of air/vapor barrier system.
- C. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane, or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

- D. Weep/Vent Products: Use the following, unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Products:
 - 1) Hohmann & Barnard, Inc.; Quadro-Vent.
 - 2) Wire-Bond; Cell Vent.
- E. Cavity Drainage Material: Free-draining mesh, made from nonabsorbent, polymer strands that will not degrade within the wall cavity.
1. Configuration: Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.
 2. Thickness: 2-inches.
 3. Product: Mortar Net; Mortar Net USA, Ltd.

2.10 CAVITY-WALL INSULATION

- A. Rigid Insulation: ASTM C1289 Type 1, Class 2, closed-cell polyisocyanurate foam insulation faced with 10.5 mil thick glass fiber reinforced foil facer on each side, exposed side shall have a 1.5 mil thick reflective aluminum facer and meeting the following physical properties:
1. Density: ASTM D 1622, nominal 2.0 pcf.
 2. Compressive Strength: ASTM D1621, 20 psi, minimum.
 3. Water Absorption: ASTM C209, less than 0.1 percent by volume.
 4. Air Permeance: ASTM E 2178, less than 0.02l/ssm.
 5. Board Size and Configuration:
 - a. Panel Size: 4 feet by 12 feet long.
 - b. Thickness: 3 inches.
 - c. Edge Condition: Square.
 6. Thermal Resistance: R-20.3.
 7. Fire Performance: Shall be compliant with NFPA 285 and UL 1715.
 8. Fire-Test-Response Characteristics: ASTM E 84, maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
 9. Product: Rmax Operating, LLC; TSX-8500.
- B. Insulation Tape: Provide board insulation manufacturer's compatible joint tape for sealing joints and brick tie penetrations through the insulation layer.
1. Facer: Aluminum foil.
 2. Adhesive: Acrylic adhesive.
 3. Width: 4 inch.
 4. Thickness: 3.3 mils.
 5. Product: Rmax Operating, LLC; R-SEAL 3000.
- C. Insulation Flashing Tape: Provide insulation manufacturer's recommended flashing tape for sealing corners, ceiling and floor transitions, exterior envelop opening penetrations and through wall penetrations.
1. Adhesive: Butyl rubber (non-asphalt).
 2. Width: 9-inch and 12-inch widths as required.
 3. Thickness: 35 mils.
 4. Product: Rmax Operating, LLC; R-SEAL 6000.

- D. Insulation Caulk: Provide insulation manufacturer's recommended caulk for sealing small penetrations.
 - 1. Product: Henry Company; Henry HE925-BES or equivalent.
- E. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.11 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate (Spic and Span) and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.
- B. Proprietary Buffered Detergent-Based Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry and precast concrete surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned. Muriatic acid is not permitted.
 - 1. Cleaners for Brick: EaCoChem; NMD 80.

2.12 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with BIA Technical Notes 8A, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For masonry below grade or in contact with earth, use Type M.
 - 2. For reinforced masonry, use Type S.
 - 3. For exterior veneer masonry, use Type N.
- D. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
 - 1. Pigments shall not exceed 10 percent of portland cement by weight.
- E. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 - 2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

- F. Concrete for Unit Masonry: 3000 psi, 28-day compressive strength. Comply with requirements of Division 03 Section "Cast-In-Place Concrete."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. If unsatisfactory conditions are encountered, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Examine wall framing, sheathing, and air/vapor barrier to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.
- B. Before installation, examine rough-in and built-in construction for piping and electrical systems to verify actual locations of piping and electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- F. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
 - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 - 3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 INSULATION INSTALLATION

- A. General: Install insulation in accordance with manufacture's written instructions.
 1. Do not install insulation on walls when water, frost or ice is present.
 2. Do not install wet insulation. Wet insulation shall be fully air dried before installing, sealing or covering.
 3. All taping and flashing of started sections of insulation installations shall be completed each day. Exposed foam edges shall be sealed with insulation tape at end of each work day.
- B. Fit courses of cavity insulation firmly against air/vapor barrier membrane or back-up wythe, with edges butted tightly both ways. Hold firmly in place until veneer anchor are installed. Install insulation with the long dimension horizontal and the foil facer facing the exterior. Each row of insulation shall be staggered a minimum of 16 inches from the row below. At corners, boards shall be overlapped tightly.
- C. Seal end and edge joints of insulation with continuous insulation joint tape, 4 inches wide, using sufficient hand pressure to ensure seal and in accordance with rigid insulation manufacturer's joint sealing recommendations.
 1. All surfaces to which the insulation joint tape is applied shall be free of moisture, oils, dust, dirt and other debris that could inhibit adhesion. Clean surfaces with a dry cloth as necessary.
 2. Center tape along insulation joints. When connection ends of tape segments, provide a minimum of 2 inch overlap.
 3. At insulation board terminations, including but not limited to, building foundations, slabs, shelf protrusions, roofing membranes, blocking for exterior envelop openings, seal insulation to adjacent surface with flashing tape.
 4. Corners shall be sealed using insulation flashing tape.
 5. At through-wall penetrations, seal penetration to insulation with 12 inch tape.
- D. Damages to foam core and foil facing shall be replaced by fully cutting out the damaged area. At steel framed walls, the removed piece shall be large enough to span entire stud spacing to ensure new joints are backed by framing. Replace removed piece with new insulation.
- E. Insulation shall be permanently held in place by masonry veneer anchors installed in paragraph 3.6 below.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay solid masonry units, including brick veneer, with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
 - 1. Full head joints in masonry veneer are required to make wall as water impermeable as possible. If field observations find head joints are not fully filled, the contractor will be required to remove brick at random locations as directed by the Architect. If additional locations are found with partially filled head joints, the masonry veneer shall be removed and new masonry veneer properly laid.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.5 CAVITY WALLS

- A. Keep cavities clean of mortar droppings and other materials during construction. Strike joints facing cavities flush.
 - 1. Use wood strips temporarily placed in cavity to collect mortar droppings. As work progresses, remove strips, clean off mortar droppings, and replace in cavity.
 - 2. Place cavity drainage mat at the base flashing of all new masonry, providing a continuous drainage system at base of wall, at heads of windows, doors, and other horizontal interruptions in cavity. (Note: It is still intended to have mortar dropping minimized through proper placement, drag boards and other methods required to keep the cavity clear.)
- B. At base of cavity wall where brick runs below grade, fill cavity solid with mortar, without voids up to an elevation above grade. Smooth top of mortar in cavity to provide a level uniform surface to receive flexible flashing.

3.6 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and with masonry-veneer anchors to comply with the following requirements:
 - 1. At steel framed walls, screw masonry anchors through insulation, air/vapor barrier membrane, and gypsum sheathing into steel studs. Press insulation tight to substrate and tighten wing nut to be flush with foil facer on insulation without damaging facer, holding insulation in place without gaps between back side of insulation and air/vapor barrier. If anchor misses stud, remove anchor and insulation, patch holes in air/vapor barrier membrane, and replace insulation with new insulation.
 - 2. Insert tie sections into anchor wing nuts.
 - 3. Embed tie sections in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of insulation.
 - 4. Space anchors as indicated in approved Shop Drawings, but not more than 16 inches o.c. vertically and 32 inches o.c. horizontally. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.

3.7 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
 - 1. Where control joints are not shown, provide control joints at a maximum spacing of 30 feet; review proposed locations with Architect prior to installation.
- B. Form expansion joints in brick as follows:
 - 1. Build in compressible joint fillers where indicated.
 - 2. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."
- C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.
 - 1. Locate horizontal, pressure-relieving joints beneath relieving angles supporting masonry.

3.8 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and at all exposed block locations.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.9 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as specified.
 - 2. Flexible flashing shall not span across a gap greater than 1/4-inch.
 - 3. Extend sheet metal flashing 3/8 inch beyond face of masonry at exterior and turn flashing down at 45 degrees to form a drip. Lap joints of metal flashing 3 inches, sealing between with full bed of asphalt mastic. Over the top of each joint, apply a 4-inch wide strip of flexible sheet flashing to both horizontal and vertical legs.
 - 4. Flexible Flashing Tie-In to Air/Vapor Barrier: Prepare surface of air/vapor barrier in accordance with air/vapor barrier manufacturer to receive flexible flashing. Run flexible flashing up face of air/vapor barrier 8 inches minimum. Flexible flashing shall be smooth, free of gaps and wrinkles. Roll surface of flexible flashing with hand roller to ensure full adhesion over the entire surface. Apply continuous bead of termination mastic along flexible flashing top edge, vertical edges, seams, cuts, and penetrations.

5. Base of Wall Flashing: Provide 3-1/2-inch wide metal drip flashing and flexible flashing. Lap flexible flashing onto sheet metal drip flashing 3 inches, stopping flexible flashing minimum 1/2-inch back from face of brick, providing continuous watertight seal between. Extend flexible flashing fully supported across mortar filled cavity and turning up wall 8 inches minimum, tying into air/vapor barrier system as specified above.
 6. At lintels, provide metal flashing extending a minimum of 8 inches into masonry at each end, turning up not less than 2 inches to form end dams with inside corners soldered. Metal flashing shall extend horizontally across lintel angle, up the vertical leg, and across the cavity to support the flexible flashing tie-in to the air/vapor barrier.
 - a. Metal flashing shall be one piece, full width of opening. Where opening width exceeds available sheet metal length, lap joints of metal flashing 3 inches, sealing between with full bed of asphalt mastic. Over the top of each joint, apply a 4-inch wide strip of flexible sheet flashing to both the horizontal and vertical legs.
 - b. Install flexible flashing tie-in to air/vapor barrier, extending a minimum of 8 inches up face of wall. Run flexible flashing full width of metal flashing, lapping beyond metal flashing ends. Run flexible flashing across insulation and metal flashing spanning cavity, and turn down face of lintel 3 inches minimum.
 7. At two-piece receiver and counterflashing furnished in Division 07 Section "Sheet Metal Flashing and Trim," install receiver, providing proper weeping and drainage to exterior. Tie in metal flashing to air/water barrier with 12 inch wide cap strip of flexible flashing, adhering 8 inches to air/vapor barrier free of gaps and wrinkles, lapping 4 inches on to metal flashing. Apply continuous bead of termination mastic along cap strip top edge.
 8. At base of wall locations where brick shelves is below finish floor elevation, the air/vapor barrier system will be applied to brick shelf as part of air/vapor barrier system specified in Division 07 Section "Fluid Applied Air/Vapor Barrier System." Where brick shelf is flush with or above finish floor elevation, provide metal drip and flexible flashing, tying into air/vapor barrier system as specified above.
- C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Space weep holes 24 inches o.c., unless otherwise indicated.
 3. Provide weep holes not more than 8 inches from end of lintels.
- D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
- E. Install vents in head joints in exterior wythes at tops of walls at spacing indicated; if spacing not indicated, space vents 64 inches o.c. Use specified weep/vent products to form vents.
- 3.10 FIELD QUALITY CONTROL
- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
1. Payment for these services will be made by Owner.
 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- B. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- C. Mortar Test (Property Specification): For each mix provided, per ASTM C 780.

3.11 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Allow mortar to cure above 45 degrees F or greater for minimum 14 days before cleaning. If cure temperature is below 45 degrees F, allow additional time above 45 degrees F to achieve the 14 day cure period to allow the mortar to cure thoroughly.
 - 2. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 3. Mix cleaner with water at manufacturer's recommended rate. Test cleaning methods on wall at an inconspicuous location.
 - 4. Protect adjacent non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 5. Lightly pre-wet wall surfaces with water before applying cleaner.
 - 6. Clean brick in accordance with manufacturer's printed instructions:
 - a. Apply cleaner with low-pressure sprayer and allow to foam and dwell until foam collapses. Reapply cleaner without rinsing until cleaner no longer foams. Do not let cleaner dry on surface.
 - b. Pressure wash surface using 25 to 40 degree wide tip nozzle. Use the minimum pressure possible, as determined by the sample test area. Rinse in overlapping pattern, maintaining tip location and pressure in a manner to prevent surface damage to masonry units and mortar joints.
- E. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.12 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Excess Masonry Waste: Remove excess clean masonry waste and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

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SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Structural steel.
 - 2. Field-installed shear connectors.
 - 3. Grout.
- B. Related Requirements:
 - 1. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
 - 2. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other steel items not defined as structural steel.
 - 3. Division 09 Section "Painting" for surface-preparation and priming requirements.

1.3 DEFINITIONS

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

1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment Drawings.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
- C. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following:
 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 2. Direct-tension indicators.
 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 4. Shear stud connectors.
 5. Shop primers.
 6. Nonshrink grout.
- F. Source quality-control reports.
- G. Field quality-control and special inspection reports.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- C. Comply with applicable provisions of the following specifications and documents:
 1. AISC 303.
 2. AISC 360.
 3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992/A 992M.
- B. Channels, Angles-Shapes: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50 (345).
- E. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B (rectangular and round), structural tubing.
- F. Corrosion-Resisting, Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.
- G. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.
- H. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
 - 1. Finish: Hot-dip zinc coating.
- D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- E. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.
 - 1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
 - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 4. Finish: Plain
- F. Threaded Rods: ASTM A 36/A 36M.
 - 1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
 - 2. Washers: ASTM A 36/A 36M carbon steel.
 - 3. Finish: Plain.
- G. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

2.4 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanizing Repair Paint: ASTM A 780/A 780M.

2.5 GROUT

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

2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.8 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 - 2. Surfaces to be field welded.
 - 3. Surfaces of high-strength bolted, slip-critical connections.
 - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 5. Galvanized surfaces.
 - 6. Surfaces enclosed in interior construction.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
 - 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 - 2. Galvanize lintels shelf angles attached to structural-steel frame and located in exterior walls.

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.

2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 3. Ultrasonic Inspection: ASTM E 164.
- D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of baseplate.
 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
 - D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 1. Level and plumb individual members of structure.
 - E. Splice members only where indicated.
 - F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
 - G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
 - H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 2. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 1. Verify structural-steel materials and inspect steel frame joint details.
 2. Verify weld materials and inspect welds.
 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

- C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
- E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Priming: Cleaning and touchup priming are specified in Division 09.

END OF SECTION 051200

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SECTION 052100 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. K-series steel joists.
 - 2. KCS-type K-series steel joists.
 - 3. K-series steel joist substitutes.
 - 4. LH- and DLH-series long-span steel joists.
 - 5. Joist accessories.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
 - 2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
 - 3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.3 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support non-uniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product.
- B. Shop Drawings:
 - 1. Include layout, designation, number, type, location, and spacing of joists.
 - 2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
 - 3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Manufacturer certificates.

- C. Mill Certificates: For each type of bolt.
- D. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
 - 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam Steel Corporation; Canam Group, Inc.
 - 2. Vulcraft; Nucor Vulcraft Group.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
 - 1. Use ASD; data are given at service-load level.
 - 2. Design special joists to withstand design loads with live-load deflections no greater than the following:
 - a. Floor Joists: Vertical deflection of 1/360 of the span.
 - b. Roof Joists: Vertical deflection of 1/360 of the span.

2.3 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
 - 1. Joist Type: K-series steel joists and KCS-type K-series steel joists.

- B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
- C. Provide holes in chord members for connecting and securing other construction to joists.
- D. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."
- E. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."
- F. Do not camber joists.
- G. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.4 LONG-SPAN STEEL JOISTS

- A. Manufacture steel joists according to "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as follows:
 1. Joist Type: LH-series steel joists.
 2. End Arrangement: Underslung Square.
 3. Top-Chord Arrangement: Parallel Pitched 1/8 inch per 12 inches (1:96), two ways.
- B. Provide holes in chord members for connecting and securing other construction to joists.
- C. Camber long-span steel joists according to SJI's "Specifications."
- D. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.5 PRIMERS

- A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.6 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
- C. Bridging: Fabricate as indicated and according to SJI's "Specifications." Furnish additional erection bridging if required for stability.

- D. Fabricate steel bearing plates from ASTM A 36/A 36M steel with integral anchorages of sizes and thicknesses indicated. Shop prime paint.
- E. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."
- F. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated.
- G. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
 - 1. Finish: Plain
- H. Welding Electrodes: Comply with AWS standards.
- I. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.7 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.
- C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.
- D. Shop priming of joists and joist accessories is specified in Division 09.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.

- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
 - 4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using carbon-steel bolts.
- E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
- F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
- C. Visually inspect bolted connections.
- D. Prepare test and inspection reports.

3.4 PROTECTION

- A. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
 - 1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2 or power-tool cleaning according to SSPC-SP 3.
 - 2. Apply a compatible primer of same type as primer used on adjacent surfaces.

END OF SECTION 052100

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SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Roof deck.
2. Acoustical roof deck.
3. Acoustical cellular roof deck.
4. Composite floor deck.

- B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
4. Division 09 Section "Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings:
 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.
- C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 1. Power-actuated mechanical fasteners.
 2. Acoustical roof deck.
- D. Evaluation Reports: For steel deck, from ICC-ES.
- E. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam Steel Corporation; Canam Group, Inc.
 - 2. Nucor Corp.
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
 - 1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - a. Color: Gray.
 - 2. Deck Profile: As indicated.
 - 3. Profile Depth: As indicated.
 - 4. Design Uncoated-Steel Thickness: As indicated.

5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
6. Span Condition: Triple span or more.
7. Side Laps: Overlapped.

2.3 ACOUSTICAL ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Canam Steel Corporation; Canam Group, Inc.
 2. Nucor Corp.
- B. Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 (Z180) zinc coating.
 2. Deck Profile: As indicated.
 3. Cellular Deck Profile: As indicated, with bottom plate.
 4. Profile Depth: As indicated.
 5. Design Uncoated-Steel Thickness: As indicated.
 6. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
 7. Span Condition: Triple span or more.
 8. Side Laps: Overlapped.
 9. Acoustical Perforations: Deck units with manufacturer's standard perforated vertical webs.
 10. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.
 - a. Factory install sound-absorbing insulation into cells of cellular deck.
 - b. Installation of sound-absorbing insulation is specified in Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing".
 11. Acoustical Performance: NRC 0.90, tested according to ASTM C 423.

2.4 COMPOSITE FLOOR DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Canam Steel Corporation; Canam Group, Inc.
 2. Nucor Corp.
- B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 (Z180) zinc coating.
 2. Profile Depth: As indicated.
 3. Design Uncoated-Steel Thickness: As indicated
 4. Span Condition: As indicated.

2.5 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
- J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.
- K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and level recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.
- L. Galvanizing Repair Paint: ASTM A 780/A 780M
- M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
 - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
 - 1. Weld Diameter: 5/8 inch (16 mm) nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
 - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 12 inches (304.8 mm), and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
 - 1. End Joints: Lapped 2 inches (51 mm) minimum.

- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches (305 mm) apart with at least one fastener at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and or mechanically fasten.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. mechanically fasten to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
- G. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing".

3.4 FLOOR-DECK INSTALLATION

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: 5/8 inch (16 mm) nominal.
 - 2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches (305 mm) apart, but not more than 18 inches (457 mm) apart.
 - 3. Weld Spacing: Space and locate welds as indicated.
 - 4. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 36 inches (914 mm), and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
 - 1. End Joints: Lapped
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.

- C. Prepare test and inspection reports.

3.6 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
 - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 - 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 09 Section "Painting".

END OF SECTION 053100

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SECTION 054000 - COLD-FORMED METAL FRAMING

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. Exterior curtain-wall framing.
 - 2. Exterior soffit framing.
 - 3. Exterior weather-resistant gypsum sheathing.
- B. Related Sections include the following:
 - 1. Division 07 Section "Building Insulation" for Z- and J-furring installed with rigid insulation at exterior walls.
 - 2. Division 07 Section "Fluid-Applied Air/Vapor Barrier System" for membrane on weather-resistant gypsum sheathing.
 - 3. Division 09 Section "Gypsum Board Assemblies" for interior non-load-bearing metal-stud framing, shaft wall assemblies, and ceiling-suspension assemblies.

1.3 DEFINITIONS

- A. Minimum Uncoated Steel Thickness: Minimum uncoated thickness of cold-formed framing delivered to the Project site shall be not less than 95 percent of the thickness used in the cold-formed framing design. Lesser thicknesses shall be permitted at bends due to cold forming.
- B. Producer: Entity that produces steel sheet coil fabricated into cold-formed members.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional structural engineer, as defined in Division 01 Section "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: As indicated on Structural Drawings.
 - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Curtain-Wall Framing:
 - 1) Horizontal deflection of 1/360 of the wall height. Confirm requirement with exterior wall cladding system manufacturer.
 - b. Exterior Soffit Joist Framing: Vertical deflection of 1/360 of the span.
 - 3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and

- anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4-inch for floor framing and floor assemblies and 1-1/2 inches for roof framing and roof assemblies.
 5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
 2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

1.5 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of cold-formed metal framing product and accessory indicated.
- C. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining Work.
 1. Delegated-Design Data: For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - a. Gages indicated are minimum allowable uncoated gage. Verify load capacity of manufacturer's product being furnished for Project.
 - b. Verify and include loading of architectural precast concrete anchor design.
- D. Welding Certificates: Copies of certificates for welding procedures and personnel.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- F. Product Test Reports: From a qualified testing agency indicating that each of the following complies with requirements, based on comprehensive testing of current products:
 1. Expansion anchors.
 2. Power-actuated anchors.
 3. Mechanical fasteners.
 4. Vertical deflection clips.
 5. Miscellaneous structural clips and accessories.

- G. Research/Evaluation Reports: Evidence of cold-formed metal framing's compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
- H. Installation of Cold-Formed Metal Framing Report: Submit copy of engineer's report of completed framing installation.
- I. Installation Inspection Report of Gypsum Sheathing: Submit report of completed work inspection, for each area that is completed and ready to turn over for application of the air/vapor barrier system.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced Installer who has completed cold-formed metal framing similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Engineering Responsibility: Engage a qualified professional structural engineer to prepare design calculations, Shop Drawings, and other structural data.
- C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- E. Fire-Test-Response Characteristics: Where metal framing is part of a fire-resistance-rated assembly, provide framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by GA File Numbers in GA-600, "Fire Resistance Design Manual," or by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
- F. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
 - 1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Truss Design."
 - 2. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."
 - 3. CCFSS Technical Bulletin: "AISI Specification Provisions for Screw Connections."
- G. Mockup Panel: Build mockup panels to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution with each trade providing components of their work. Mockup shall demonstrate installation of cold-formed metal framing, gypsum sheathing, air/vapor barrier membrane, insulation, face veneers, storefront, and indicated accessories.
 - 1. Locate mockups in the location indicated or, if not indicated, as directed by Architect.
 - 2. Prepare mockups for review at Preinstallation Conference.

3. Mockup Panel: Build a braced, L-shaped mockup panel with each leg 72 inches long by 96 inches high by full thickness of exterior cold-formed framing with weather-resistant gypsum sheathing for application of other components, including air/vapor barrier, insulation, wall cladding, and storefront window. Include a framed opening 24 inches wide by 32 inches high in each leg that will receive a storefront window; locate sill of framed opening 32 inches above bottom of panel.
 4. Air/Vapor Barrier Mockup Panel: Build a braced mockup panel 60 inches long by 72 inches high by full thickness of exterior cold-formed framing with weather-resistant gypsum sheathing for application of air/vapor barrier. Include a framed opening 24 inches wide by 32 inches high. Locate sill of framed opening 24 inches above bottom of panel.
 5. Protect accepted mockups from the elements with weather-resistant membrane. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Demolish and remove mockups when directed by Architect.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
- I. Inspection of Cold-Formed Metal Framing: Prior to applying gypsum sheathing, engineer responsible for the design of framing shall inspect framing installation for compliance with design.
- J. Installation Inspection: Contractor and Installer shall inspect completed cold-formed metal framing and sheathing installation for compliance with installation specifications and details and submit a report for each area that is completed and ready to turn over for application of the air/vapor barrier system. Report shall include the following:
1. All required framing and bracing is installed in exterior walls to receive sheathing, z-furring, and other components of the exterior skin of the building.
 2. Verify proper attachment and spacing of anchors in top and bottom tracks to meet design loading requirements.
 3. At deflection track locations, verify that studs are not screwed to track, permitting proper free sliding of studs in the track.
 4. Sheathing has proper uniform gap at deflection tracks to permit full deflection. Verify sheathing edges are not screwed to the deflection track.
 5. Verify sheathing attachment screw quantity and spacing per board is correct.
 6. Verify screw head penetration is at the proper location to be in compliance with the sheathing manufacturer's requirements.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
 - B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.
 - C. Gypsum Sheathing: Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cold-Formed Metal Framing:
 - a. Clark Dietrich Building Systems, Inc.
 - b. Marino\Ware; Div. of Ware Industries, Inc.
 - c. Super Stud Building Products, Inc.
 2. Glass-Mat Gypsum Sheathing Board:
 - a. Dens-Glass Sheathing; Georgia-Pacific Corporation.
 - b. GlasRoc Sheathing; CertainTeed Corporation.
 - c. Expended Exposure Sheathing e²xp; National Gypsum Company.

2.2 MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, of grade and coating weight as follows:
1. Grade: As required by structural performance.
 2. Coating: G90.

2.3 LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, complying with ASTM C 955, and as follows:
1. Minimum Uncoated-Steel Thickness: As indicated on Structural Drawings.
 2. Flange Width: 1-5/8 inches, unless indicated otherwise.
 3. Sizes: As required for specified design requirements, but not less than indicated on Drawings.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, complying with ASTM C 955, and as follows:
1. Minimum Uncoated-Steel Thickness: Not less than steel studs in material, gage, and finish.
 2. Flange Width: 1-1/4 inches, unless indicated otherwise.

2.4 CURTAIN-WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, complying with ASTM C 955, and as follows:
1. Minimum Uncoated-Steel Thickness: Not less than 0.0428 inch, 18 gage, including cripple studs, short stud infill, and structural steel infill.
 2. Flange Width: 2 inches.
 3. Sizes: As required for specified design requirements, but not less than indicated on Drawings.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, complying with ASTM C 955, and as follows:

1. Minimum Uncoated-Steel Thickness: Not less than steel studs in material, gage, and finish.
 2. Flange Width: Not less than 1-1/4 inches.
- C. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads, and as follows:
1. Minimum Uncoated-Steel Thickness: Not less than steel studs in material, gage, and finish; gage as required to resist loading indicated.
 2. Flange Width: Not less than 2 inches to allow for 1-inch deflection at floor levels and not less than 3 inches to allow for 1-1/2 inches of deflection at roof levels.
- D. Bridging:
1. Minimum Uncoated-Steel Thickness: Not less than steel studs in material, gage, and finish.
 2. Shape: Cold-formed channel section.
 3. Size: 1-1/2 inches web depth.
- E. Deflection Brackets:
1. Product: VertiClip; Signature Industries; (919) 844-0789.
 2. Construction: Slotted galvanized steel angle with step bushing to prevent over tightening of fasteners.
 3. Vertical Deflection: 1-1/2 inches total travel at floor levels and 3-inches total travel at roof levels.
 4. Series: SL, SDL, SLB, AND SLS as required by attachment condition.

2.5 EXTERIOR SOFFIT (CEILING JOIST) FRAMING

- A. Steel Soffit (Ceiling Joists) Framing: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, complying with ASTM C 955, and as follows:
1. Minimum Uncoated-Steel Thickness: Not less than 0.0329 inch.
 2. Flange Width: 1-5/8 inches, minimum.
 3. Sizes: Not less than indicated.

2.6 FRAMING ACCESSORIES

- A. Miscellaneous Framing Components: Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members, with a minimum yield strength of 33,000 psi.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. General: Provide required or indicated items; provide galvanized fasteners for assemblies having galvanized major steel components.
- B. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

- C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
- D. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.

2.9 EXTERIOR SHEATHING

- A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177; moisture- and mold-resistant core and facers.
 - 1. Type and Thickness: Type X, 5/8 inch thick.
 - 2. Moisture- and Mold-Resistance: ASTM D3273, rating of 10.
 - 3. Size: 48 by maximum available lengths.
- B. Gypsum Sheathing Fasteners for Metal Framing: Steel drill screws, ASTM C 954, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
- B. Install cold-formed metal framing and accessories plumb, square, and true to line, with lateral bracing and bridging, and with connections securely fastened, according to referenced standards, manufacturer's written recommendations and requirements in this Section.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed metal framing members by welding or screw fastening, as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

- b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads. Use minimum of 2 self-tapping metal screws per connection, unless otherwise indicated.
- C. Install framing members in one-piece lengths, unless splice connections are indicated for track or tension members. Splicing of load bearing components and curtain wall studs is prohibited.
- D. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- E. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- F. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location and a maximum of 2 inches from abutting walls. Construct corners using minimum of three studs. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Align top and bottom tracks; locate as indicated, and secure track to substrates at spacing required on engineered Shop Drawings, but not more than 24 inches on center, using fastening methods specified in manufacturer's printed installation instructions for Project substrate types.
 - 3. Install double studs at jambs of openings for doors, cased openings, and windows; install intermediate studs above and below openings to align with wall stud spacing.
 - 4. Seat studs in track, square with track flange, with stud end maximum 1/16 inch from surface of track web.
 - 5. Attach cross studs for attachment of fixtures; install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
 - 6. Provide web stiffeners at locations indicated or required.

3.3 CURTAIN-WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to bottom track only, unless otherwise indicated. Do not fasten studs to deep-leg deflection tracks. Space studs as follows:
 - 1. Stud Spacing: 16 inches, unless otherwise indicated .
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.

- E. Install horizontal bridging in curtain-wall studs, spaced in rows indicated on Shop Drawings but not more than 54 inches apart. Fasten at each stud intersection.
 - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable curtain-wall-framing system.

3.4 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Space joists not more than 2 inches from abutting walls, and as follows:
 - 1. Joist Spacing: As indicated.
- D. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Shop Drawings.
 - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at each end of joists and at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
 - 1. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.5 INSTALLATION OF EXTERIOR SOFFIT (CEILING JOIST) FRAMING

- A. Install perimeter soffit framing (joist) track sized to match soffit framing (joists). Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install soffit framing (joists) bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten soffit framing (joists) to both flanges of joist track.
 - 1. Install soffit framing (joists) over supporting frame with a minimum end bearing of 1-1/2 inches.
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Space soffit framing (joists) not more than 2 inches from abutting walls, and as follows:
 - 1. Soffit Framing (Joist) Spacing: 16 inches.
- D. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
- E. Install bridging at each end of soffit framing (joists) and at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
 - 1. Soffit Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

3.6 EXTERIOR SHEATHING INSTALLATION

- A. General: Install gypsum sheathing to comply with GA-253 and manufacturer's written instructions.
- B. Cut boards at penetrations, edges, and other obstructions of the work; fit tightly against abutting construction, except provide a 3/8-inch setback where construction abuts structural elements.
- C. Coordinate sheathing installation with flashing and joint sealant installation so these materials are installed in the sequence and manner that prevent exterior moisture from passing through completed exterior wall assembly.
- D. Apply fasteners so screw heads bear tight against but flush with surface of sheathing boards. Do not cut into facing.
- E. Do not bridge building expansion joints and deflection joints with sheathing; cut and space edges to match spacing of structural support elements. Do not screw edges of sheathing to deflection track.
- F. Horizontal Installation: Abut ends of boards over centers of stud flanges and stagger end joints of adjacent boards not less than one stud spacing. Screw-attach boards at perimeter and within field of board to each steel stud at approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

3.7 FIELD QUALITY CONTROL

- A. Inspection of Cold-Formed Metal Framing: Prior to applying gypsum sheathing, engineer responsible for the design of framing shall inspect framing installation for compliance.
- B. Field and shop welds will be subject to inspection and testing.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace Work that does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

3.8 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Protect cutouts, corners, and joints in sheathing by filling with a flexible sealant or by applying tape recommended by sheathing manufacturer at time sheathing is applied.
- C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure cold-formed metal framing and sheathing are without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

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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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Ladders.
 - 2. Loose steel lintels.
 - 3. Steel framing and supports for the following:
 - a. Entrances and storefronts.
 - b. Roof openings.
 - c. Steel framing and supports for mechanical and electrical equipment.
 - d. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 4. Steel weld plates and angles for casting into concrete not specified in other Sections.
 - 5. Rough hardware.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Anchor bolts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
- C. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, wedge-type inserts and other items indicated to be cast into concrete and for concrete fill for stair treads and platforms.
 - 2. Division 05 Section "Structural Steel" for relieving angles attached to structural steel.
 - 3. Division 06 Section "Rough Carpentry" for concealed wood blocking for anchoring railings attached to walls.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For the following:
 - 1. Paint products.
 - 2. Grout.

- C. Shop Drawings: Show fabrication and installation details for railings, infill system, guardrails and metal fabrications.
 1. Include plans, elevations, sections, and details of railings, infill system, guardrails and metal fabrications and their connections. Show anchorage and accessory items.
 2. Provide templates for anchors and bolts specified for installation under other Sections.
 3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Delegated-Design Submittal: For metal fabrications, and railings indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Welding Certificates: Signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- F. Qualification Data: For professional engineer.

1.5 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. Professional Engineer Qualifications: Professional structural engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for design of concrete filled steel pan stairs that are similar to those indicated for this Project in material, design, and extent.
- C. Welding: Qualify procedures and personnel according to the following:
 1. AWS D1.1, "Structural Welding Code--Steel."
 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
 3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.
 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Coordinate installation of steel weld plates and angles for casting into concrete or built into unit masonry that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

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

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 1. Galvanized finish for exterior installations and where indicated.
- B. 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.
- C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
 - 1. Black finish, unless otherwise indicated.
 - 2. Galvanized finish for exterior installations and where indicated.
- D. Malleable-Iron Castings: ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010).

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

- D. Anchor Bolts: ASTM F 1554, Grade 36.
 - 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
- E. Eyebolts: ASTM A 489.
- F. Machine Screws: ASME B18.6.3.
- G. Lag Bolts: ASME B18.2.1.
- H. Wood Screws: Flat head, ASME B18.6.1.
- I. Plain Washers: Round, ASME B18.22.1.
- J. Lock Washers: Helical, spring type, ASME B18.21.1.
- K. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.
- L. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material for Anchors in Exterior Locations: Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.
- M. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as required.
- N. Chemical Anchors: Two-part epoxy systems with impacted bolt, rod or anchor as follows:
 - 1. Concrete Anchor: Epoxy capsule system similar to Hilti HVA Adhesive Anchor System, Ramset Chemset anchor system, or approved equal.
 - 2. Masonry Anchor: Epoxy injection system similar to Hilti HIT C-100 System.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint system indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. 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.
 - 1. Products:
 - a. Sure-grip High Performance Grout; Dayton Superior Corp.
 - b. Euco N-S Grout; Euclid Chemical Co.
 - c. Five Star Grout; Five Star Products.
 - d. Crystex; L & M Construction Chemicals, Inc.
 - e. Masterflow 928 and 713; Master Builders Technologies, Inc.
 - f. Sealtight 588 Grout; W. R. Meadows, Inc.
 - g. SonogROUT 14; Sonneborn Building Products - ChemRex, Inc.
- F. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than 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.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- F. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

- H. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- I. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- J. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
 - 1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 METAL LADDERS

- A. General:
 - 1. Comply with ANSI A14.3, unless otherwise indicated.
 - 2. For elevator pit ladders, comply with ASME A17.1.
 - 3. Space siderails 18 inches apart for elevator pit ladders and 24 inches apart for other ladders, unless otherwise indicated.
 - 4. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder.
 - a. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches, except as otherwise indicated.
 - 1) For elevator pit ladders, hold centerline of ladder rungs clear of the wall surface by not less than 5 inches.
 - b. Extend siderails 48 inches above top rung and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, gooseneck the extended rails back to the structure to provide secure ladder access.
- B. Steel Ladders:
 - 1. Siderails: As indicated on Drawings.
 - 2. Rungs: 1-inch- diameter steel bars, spaced 12 inches o.c.
 - 3. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 - 4. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports for applications indicated that are not specified in other Sections as needed to complete the Work.

- B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
 - a. Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.
 - 2. Furnish inserts if units are installed after concrete is placed.
- C. Fabricate supports for all glass entrances and storefronts from continuous steel members of sizes indicated with attached supports, anchors, and braces as indicated.
- D. Galvanize miscellaneous framing and supports at exterior locations and where indicated.

2.8 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.

2.9 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 06 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.

2.10 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.11 STEEL AND IRON FINISHES

- A. Galvanizing: Provide coating for iron and steel fabrications applied by the hot-dip process, 0.05 - 0.09% nickel content, Duragalv by Duncan Galvanizing, or approved equal. Provide thickness

of galvanizing specified in referenced standards. Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing both fabricated and unfabricated steel and iron products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick or thicker.
 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
 3. Galvanizing shall exhibit a rugosity (smoothness) not greater than 4 rug (16-20 microns of variation) when measured by a profilometer over a 1-inch straight line on the surface of architectural and structural elements that are less than 24 pounds per running foot. Profilometer shall be capable of operating in 1 micron increments.
- 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/NACE No. 3, "Commercial Blast Cleaning."
 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 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. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

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

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Section "Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

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SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOUCMENTS

- 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. Wood blocking and nailers.
 - 2. Plywood backing panels.
 - 3. Blocking for toilet accessories.
- B. Related Sections include the following:
 - 1. Division 05 Section "Cold-Formed Metal Framing" for weather-resistant gypsum sheathing applied to cold-formed framing.

1.3 DEFINITIONS

- A. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise indicated.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- C. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NELMA - Northeastern Lumber Manufacturers Association.
 - 2. NLGA - National Lumber Grades Authority.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.
 - 2. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
 - 3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

- C. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
 - 1. Fire-retardant-treated wood and plywood.
 - 2. Power-driven fasteners.
 - 3. Powder-actuated fasteners.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Fire-Retardant-Treated Wood and Plywood: Obtain each type of fire-retardant-treated wood product through one source from a single producer for both treatment and fire-retardant formulation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack plywood and other panels flat. Place spacers between each bundle of lumber, plywood, and panel products to provide air circulation. Provide for air circulation around stacks and under coverings.
 - 1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 WOOD AND PANEL PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 3. Provide dressed lumber, S4S, unless otherwise indicated.
 - 4. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

2.2 MISCELLANEOUS LUMBER

- A. General: Provide lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
- B. For items of dimension lumber size, provide Construction, Stud, or No. 2 or better grade lumber with 19 percent maximum moisture content and the following species:
 - 1. Spruce-pine-fir; NLGA or NeLMA.

- C. For concealed boards, provide lumber with 19 percent maximum moisture content and the following species and grades:
 - 1. Spruce-pine-fir, Standard or 3 Common grade; NeLMA or NLGA.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.3 PLYWOOD BACKING PANELS

- A. Telephone, Data, and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2 inch nominal thickness.

2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, in roof area, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 - 2. For sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 - 3. Where preservative-treated lumber or plywood is used, provide stainless steel fasteners.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening Plywood Sheathing to Cold-Formed Metal Framing: Hilti Kwik-Flex or Elco Dril-Flex; no substitution, 10-24 x 1-1/4" wafer head #3.
- A. Screws for Fastening Wood Blocking to Cold-Formed Metal Framing: ASTM C 954, self-drilling #14 steel screws with large diameter, low profile pancake head with a 6-lobe drive, epoxy or organic-polymer coated for corrosion protection. Provide fasteners of sufficient length to penetrate through wall assembly and into light gage metal framing 1/4-inch minimum, and not less than three full screw threads. Provide fasteners of sufficient length for window blocking to penetrate the light gage metal framing 1/4-inch minimum, and not less than three full screw threads.
 - 1. Product: TruFast SIP Panel Fasteners; SFSintec Deckfast Black Senti XP; FastenMaster HeadLok heavy duty flathead fastener; or approved equal.
- B. Lag Bolts: ASME B18.2.1.
- C. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- C. Do not use panel materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- D. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
- E. Securely attach rough carpentry and panel work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 3. National Evaluation Report No. NER-272 for pneumatic or mechanical driven staples, P-Nails, and allied fasteners.
- F. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.
 - 1. Use hot-dip galvanized or stainless steel fasteners where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity.
 - 2. Use stainless steel fasteners only when fastening to or into pressure preservative treated materials.
- G. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- H. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Install wood blocking and nailers to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, millwork, casework, furnishings, projection screens, window treatment, handrail bracket, building specialties, window sills, drywall window return shims, countertop supports, and miscellaneous items and fabrications, Owner furnished items, metal flashing, siding and trim

support, roof blocking, base flashing backer, and equipment supports, or similar construction. Provide 3/4-inch thick plywood covering a minimum of 32 inches square for toilet accessories. Provide 1-1/2 inch thick blocking minimum, for grab bars and handrail supports. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

1. Install blocking for grab bars and handrail supports to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.
 2. Provide concealed wood blocking behind gypsum wallboard where door stops are to be installed.
 3. Provide concealed wood blocking for board paneling.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build anchor bolts into masonry during installation of masonry work. Where possible, secure anchor bolts to formwork before concrete placement.
- C. Perimeter Wood Blocking for Storefront and Curtain Wall Framing: Screw attach wood blocking to the light gage metal framing and CMU. Provide two screws 2 inches from the ends of each piece of wood blocking, and along the length of the blocking at maximum spacing of 12 inches on center in a staggered pattern.
- D. Roofing Nailers: Install wood nailers of same total thickness as insulation. Anchor perimeter nailers to substrate in a manner to resist a force of 200 pounds per linear foot in any direction. Top nailer shall be fastened through the lower layers and into metal deck.

END OF SECTION 061000

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SECTION 062000 - FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 1. Stepped seating risers.
 2. Tackable display boards.
 3. Reinforced fiberglass wall protection systems.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of process and factory-fabricated product. Include construction details, material descriptions, dimensions of individual components and profiles, textures, and colors.
 1. For adhesives and glues used inside the weatherproofing system, include a printed statement of the VOC content.
- C. Maintenance Data: For fiberglass reinforced wall protection systems to include in the operation and maintenance manual specified in Division 01.
 1. Include cleaning methods, cleaning solutions recommended, and stain removal methods recommended.
 2. Also include precautions for cleaning materials and methods that could be detrimental to finishes and performance.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Where fire-retardant materials are indicated, provide materials with specified fire-test-response characteristics as determined by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency on surfaces of materials that will be concealed from view after installation. Materials shall meet the following requirements when tested in accordance with ASTM E 84:
 1. Flame Spread: 25 or less.
 2. Smoke Developed: 450 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store fiberglass reinforced, wall protection materials in original undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and out of direct sunlight.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations for Interior Carpentry: Do not deliver or install interior finish carpentry until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and provisions are made to maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
 - 1. Fiberglass Reinforced, Wall Protection Systems: Do not install until ambient temperature within the building is maintained at not less than 70 deg F for not less than 72 hours before, during and after installation.

PART 2 - PRODUCTS

2.1 STAIRS

- A. Interior Carpeted Stairs Risers:
 - 1. Treads: 3/4-inch plywood.
 - 2. Risers: 2 layers 3/8-inch plywood formed to radius as indicated.
 - 3. Platform Framing: Interior dimensional framing lumber.

2.2 TACKABLE DISPLAY BOARDS (HOMOSOTE)

- A. Recycled Content of Tackable Wall Panels: Provide products with an average recycled content so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 90 percent.
- B. Paintable Tack Panels: Interior tackable panels, 1/2-inch thick, composed of wood fiberboard free of asbestos or formaldehyde; Class A rated. Provide metal frame clips and adhesive for panel installation.
 - 1. Product: NCFR; Homosote Company.
- C. Metal Trim for Tack Panels: Extruded aluminum, alloy 6063-T5, 0.050 inch thick, 10 foot long; clear anodized finish.
 - 1. Product: MM Systems Corporation; Drywall Reveal Trim (J-Shape), Style No. DRT 12; or approved equal from Pittcon Industries or Gordon, Inc.
- D. Location: ART 132 display wall

2.3 WALL PROTECTION SYSTEM

- A. Fiberglass Reinforced Wall Panel (FRP): Panels, 0.090 inch thick by 4 feet by full height, with PVC inside and outside corners, and 1-inch wide, minimum, H-molding. Use adhesive and caulking as specified by manufacturer. Color for panel and molding shall match.
 - 1. Color: As indicated.

2. Products:
 - a. Crane Composites, Inc.; Kemlite Glasboard P with Surfaseal.
 - b. Panolam Industries; Panolam FRP.

B. Adhesive: Comply with paneling manufacturer's recommendations for adhesives.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours, unless longer conditioning is recommended by manufacturer.

3.3 FRP INSTALLATION

- A. Install according to manufacturer's recommendations. Set fiberglass reinforced panel edges in silicone sealant. Perimeter and H-moldings shall be fastened through the wallboard to studs or blocking back-up. Provide continuous cove base molding at the bottom of fiberglass panels, set in sealant. Apply wall panels with adhesive, allowing proper clearance for expansion and contraction. Brace wall panels to assure even contact to wall until adhesive has cured.

END OF SECTION 062000

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SECTION 062013 - EXTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Laminated Bamboo Rainscreen siding and soffits.
 - 2. Laminated Bamboo dimensional panels for exterior trim
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.
 - 2. Section 099000 "Painting", for exterior finishes

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained. Include chemical-treatment manufacturer's written instructions for finishing treated material.
 - 2. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
 - 3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.
 - 4. Include copies of warranties from chemical-treatment manufacturers for each type of treatment.
- B. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.
- C. Samples for Verification:
 - 1. For each species and cut of lumber and panel products, with 1/2 of exposed surface finished; 50 sq. in. (300 sq. cm) for lumber and 8 by 10 inches (200 by 250 mm) for panels.
 - 2. For laminated bamboo siding and panels, 50 sq. in. (300 sq. cm) for board types and 8 by 10 inches (200 by 250 mm) for panels.

1.4 INFORMATIONAL SUBMITTALS

- A. Compliance Certificates:
 - 1. For lumber that is not marked with grade stamp.
- B. Sample Warranties: For manufacturer's warranties.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecast weather conditions permit work to be performed and at least one coat of specified finish can be applied without exposure to rain, snow, or dampness.
 - 1. For exterior ornamental wood columns, comply with manufacturer's written instructions and warranty requirements.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.8 WARRANTY

- A. Manufacturer's Warranty for Laminated Bamboo Rainscreen Siding and accessories/clips: Manufacturer agrees to repair or replace siding that fails in materials or workmanship within specified warranty period. Failures include, but are not limited to, deformation or deterioration beyond normal weathering.
 - 1. Warranty Period for Factory-Applied Finish: Five years from date of Substantial Completion.
 - 2. Warranty Period for Siding (Excluding Finish): 10 years from date of Substantial Completion.
 - 3. Warranty Period for accessories and clips: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and the following grading rules:
1. NeLMA: Northeastern Lumber Manufacturers' Association, "Standard Grading Rules for Northeastern Lumber."
 2. NLGA: National Lumber Grades Authority, "Standard Grading Rules for Canadian Lumber."
 3. RIS: Redwood Inspection Service, "Standard Specifications for Grades of California Redwood Lumber."
 4. SPIB: The Southern Pine Inspection Bureau, "Standard Grading Rules for Southern Pine Lumber."
 5. WCLIB: West Coast Lumber Inspection Bureau, Standard No. 17, "Grading Rules for West Coast Lumber."
 6. WWPA: Western Wood Products Association, "Western Lumber Grading Rules."
- B. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
1. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.
- C. Softwood Plywood: DOC PS 1.
- D. Hardboard: ANSI A135.4.

2.2 LAMINATED BAMBOO RAINSCREEN SYSTEM

- A. Lamboo Elements Rainscreen System,: Used for siding and exterior soffits.
1. Material: Laminated bamboo and resin boards, carbonized, exterior grade
 2. Nominal Size Planks: 1"x 6" with shiplap edges integral to clip system, 3/16" gaps.
 3. Vertical Edge Treatment: butt joint
 4. Rainscreen Clip Assembly: Manufacturer's standard concealed rainscreen clip assembly with starter clips and field clips' aluminum.
 5. Furring: Nominal 1" x 3" (3/4" x 2 3/4" actual) rot resistant furring assembly by manufacturer, predrilled for fasteners.
 6. Finish: Factory prefinished (1) coat of translucent satin wood finish, refer to specification 099000 – Painting.

2.3 PLYWOOD SHEATHING

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Georgia Pacific or equal.
- B. Plywood Sheathing Type: Exterior, Grade CDX, APA-rated siding., Southern Yellow Pine, 19-32" thickness (.578") 5 ply, Class III or C, Square Edge, Flame Spread <200, Smoke Development, 450.

- C. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
 - 1. For prefinished items, provide matching prefinished aluminum fasteners where face fastening is required.
- D. Flashing: Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim" for flashing materials installed in exterior finish carpentry.
 - 1. Horizontal Joint Flashing for Panel Siding: Preformed, prefinished-aluminum, Z-shaped flashing.
- E. Sealants: Latex, complying with ASTM C 834 Type P, Grade NF and with applicable requirements in Section 079200 "Joint Sealants," recommended by sealant manufacturer and manufacturer of substrates for intended application.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. BASF Corporation-Construction Systems.
 - b. Bostik, Inc.
 - c. Pecora Corporation.

2.4 FABRICATION

- A. Back out or kerf backs of standing and running trim wider than 5 inches (125 mm), except members with ends exposed in finished work.
- B. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Prime lumber and moldings to be painted, including both faces and edges, unless factory primed. Cut to required lengths and prime ends.

- C. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
 - 1. Do not use manufactured units with defective surfaces, sizes, or patterns.
- D. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut exterior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
 - 3. Coordinate exterior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.

3.3 LAMINATED BAMBOO RAINSCREEN SYSTEM

- A. Install siding to comply with manufacturer's written instructions and warranty requirements.
 - 1. Provide mitered corners as indicated.
- B. Flashing: Install metal flashing as indicated on Drawings and as recommended by siding manufacturer.

3.4 ADJUSTING

- A. Replace exterior finish carpentry that is damaged or does not comply with requirements. Exterior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.5 CLEANING

- A. Clean exterior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.6 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062013

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SECTION 064000 - ARCHITECTURAL WOODWORK

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, but is not limited to, the following:
 1. Interior standing and running trim.
 2. Wood casework.
 3. Plastic-laminate cabinets.
 4. Solid-surfacing-material countertops.
 5. Specialty millwork.
 6. Flush wood paneling.
 7. Shop finishing interior woodwork.
- B. Related Sections include the following:
 1. Division 06 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
 2. Division 06 Section "Finish Carpentry" for painted tackable surfaces (Homasote) and interior carpentry exposed to view that is not specified in this Section.
 3. Division 09 Section "Painting" for field finishing of interior architectural woodwork.
 4. Division 22 Sections for plumbing integrated into casework.
 5. Division 26 Sections for conduit, wiring, and lighting integrated into casework.

1.3 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items, unless concealed within other construction before woodwork installation.
- B. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including visible surfaces in open cabinets or behind glass doors.
- C. Semiexposed Surfaces of Casework: Surfaces behind opaque doors or drawer fronts, including interior faces of doors and interiors and sides of drawers. Bottoms of wall cabinets are defined as "semiexposed."
- D. Concealed Surfaces of Casework: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, bottoms of drawers, and ends of cabinets installed directly against and completely concealed by walls or other cabinets. Tops of wall cabinets and tall cabinets are defined as "concealed."

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated, including cabinet hardware and accessories, and finishing materials and processes.
 - 1. For installation adhesives and sealants, include a printed statement of the VOC content.
- C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show details full size.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, and other items installed in architectural woodwork.
- D. Samples for Verification: For the following:
 - 1. Lumber with or for transparent finish (stained), 5 inches wide by 24 inches long, for each species and cut, finished on 1 side and 1 edge.
 - 2. Wood-veneer-faced panel products with or for transparent finish (stained), 8 by 10 inches, for each species and cut. Include at least one face-veneer seam and finish as specified.
 - 3. Solid-surfacing materials, 6 inches square.
 - 4. Exposed cabinet hardware and accessories, one unit for each type and finish.
- E. Product Certificates: Signed by manufacturers of woodwork certifying that products furnished and construction provided comply with requirements.
- F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced Installer who has completed architectural woodwork similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Fabricator Qualifications: A firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production and installation of interior architectural woodwork.

- D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards, Eight Edition" for grades of interior architectural woodwork, construction, finishes, and other requirements.
 - 1. The Contract Documents contain selections chosen from options in the Quality Standards as well as additional requirements beyond those of the Quality Standard. Comply with such selections and requirements in addition to the Quality Standard.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soilage, and deterioration.
- B. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by accurate field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

1.8 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.
- B. Coordinate locations and sizes of plumbing fixtures that will penetrate countertops.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Species and Cut for Transparent Finish: Select white birch, plain sawn or sliced.

- C. Wood Species for Opaque Finish: Any closed-grain hardwood.
- D. Wood Products: Comply with the following:
 - 1. Hardboard: AHA A135.4.
 - 2. Medium-Density Fiberboard, MDF: ANSI A208.2, Grade MD-21, 48 lb. density.
 - 3. Particleboard: ANSI A208.1, Grade M-2.
 - 4. Softwood Plywood: DOC PS 1, Medium Density Overlay.
 - 5. Hardwood Plywood and Face Veneers: HPVA HP-1, Grade A veneers.
 - a. Veneer Core Construction, All Locations Except as Noted: Veneer core plywood, no voids; poplar core veneers.
 - 1) 3/4-Inch Thickness: 7 plies.
 - 2) 1/2-Inch Thickness: 5 plies.
 - 3) 1-Inch Thickness: 9 plies.
 - b. Veneer Core Construction, Door Fronts, and Paneling: MDF core.
- E. High-Pressure Decorative Laminate, PL1: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.
 - 1. Manufacturer: As indicated on Materials Legend.
 - 2. Color, Pattern, and Finish: As indicated on Materials Legend.
- F. Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 1 mm and 3 mm thick, with radiused edges. Hot melt adhesive application.
- G. Solid-Surfacing Material, SS1 and SS2: Homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without a precoated finish.
 - 1. Manufacturer: As indicated on Materials Legend.
 - 2. Color, Pattern, and Finish: As indicated on Materials Legend.

2.2 CABINET HARDWARE

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware."
- B. Hardware Standard: Comply with BHMA A156.9 for items indicated by referencing BHMA numbers or items referenced to this standard.
- C. Butt Hinges: 2-3/4-inch, 5-knuckle steel hinges made from 0.095-inch- thick metal with antifriction bearings and rounded tips, and as follows:
 - 1. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.
 - 2. Provide 2 for doors less than 28 inches high; 3 for doors 48 to 62 inches high; and 4 hinges for doors more than 62 inches high.
- D. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 3-dimensional adjustable, self-closing, slide on technique, all metal.
 - 1. Product:
 - a. Grass 1200.
 - b. MEPLA SSP 65-254-200.
- E. Pivot Hinge: Stanley No. 340, US 26D.

- F. Display Case Door Hinges: Stanley 314 1/4, heavy gage continuous hinge, sized for door weight to support glass door weight and prevent sagging.
- G. Gate Spring Pivots: Pivots for serving counter gate shall be Bommer Type 7312, flat bracket; double-acting spring pivot with US 26D finish.
- H. Wire Pulls: Back mounted, 4 inches long, 5/16 inch in diameter.
 - 1. Manufacturers: Ives or Stanley.
- I. Catches: Provide 2 catches on doors more than 48 inches high.
 - 1. Heavy-duty magnetic catches, BHMA A156.9, B03171.
 - a. Product: Catch No. 918; Knape & Vogt Mfg. Co.
 - 2. Heavy duty roller catches with conical spring and full lip strike.
 - a. Product: Roller latch No. 335; H. B. Ives.
- J. Adjustable Shelf Standards and Supports:
 - 1. Surface Mounted Standards and Supports: Heavy duty steel standards with 2 inch o.c. adjustment complying with BHMA A156.9, B84102; with heavy duty steel shelf brackets, B84112; nickel finish.
 - a. Product: Standard No. 87 and bracket No. 187 with No. 211 and 212 shelf rests; Knape & Vogt Mfg. Co.
- K. Shelf Rests: BHMA A156.9, B04013.
 - 1. Plastic Shelf Rest: Polycarbonate resin, heavy-duty double pin shelf rest with shelf lock for 5 mm diameter drilled holes spaced at 32 mm o.c.; shelf lock shall accommodate 3/4-inch thick and 1-inch thick shelves; and capable of supporting up to 500 lbs.
 - a. Product: Allen Field Manufacturing & Development; HD Double Pin No. 55536.
- L. Drawer Slides: Side-mounted, full-extension, epoxy-coated steel drawer slides with steel ball bearings, BHMA A156.9, B05091, and rated for the following loads:
 - 1. Box Drawer Slides: 100 lbf.
 - 2. File Drawer Slides: 150 lbf.
 - 3. Pencil Drawer Slides: 45 lbf.
- M. Drawer and Cupboard Locks: Cylindrical type, 5-pin tumbler and cam, brass with chrome-plated finish, complying with BHMA A156.11, Grade 1.
 - 1. Timberline; CompX deadbolt door locks; tall cabinets System 260.
 - 2. Provide minimum of 2 keys per lock and 6 master keys.
 - 3. Each room shall be keyed according to Owner's instructions. Provide on all drawers and doors.
 - a. Provide barlock multipoint locks for tall cabinets.
- N. Wardrobe Rod: Stainless steel clad tubing, 1-1/16 inch diameter and steel closet pole sockets.
 - 1. Products:
 - a. Rod: No 770 1, Knape & Vogt Mfg. Co.
 - b. Sockets: No. 764 Knape & Vogt Mfg. Co.
- O. Garment Hooks: Cast aluminum.
 - 1. Wardrobe Hook: No. 581, H. B. Ives.
 - 2. Ceiling Hook: No. 580, H. B. Ives.

- P. Grommets for Cable Passage through Countertops: Molded-plastic grommets and matching plastic caps with slot for wire passage; color and size as selected by Architect.
 - 1. Manufacturers:
 - a. Doug Mockett and Co., Inc.
 - b. Outwater Plastics, (800) 631-8375.
- Q. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
 - 2. Satin Stainless Steel: BHMA 630.
- R. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.3 CABINET ACCESSORY MATERIALS

- A. Counter Bracket Supports: Fabricated of 6063 T-6, T-shaped extruded aluminum; MIG welded along 45 degree miters and along back; pre-punched for 1/4-inch fasteners; provide rubber grommet in 7/8-inch hole; powder coated finish; Rakks, Rangine Corp., Millis, MA.

2.4 INSTALLATION MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Screws: Select material, type, size, and finish required for each use and substrate. Comply with ASME B 18.6.1 for applicable requirements.
 - 1. For metal framing supports, provide screw as recommended by metal-framing manufacturer.
- C. Nails: Select material, type, size, and finish required for each use. Comply with FS FF-N-105 for applicable requirements.
- D. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- E. VOC Limits for Installation Adhesives and Glues: Installation adhesives and glues used inside the weatherproofing system shall have the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Wood Glues: 30 g/L.
 - 2. Contact Adhesive: 250 g/L.

2.5 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade indicated and any additional

requirements of this Section. When quality grade is not indicated, provide Custom quality grade.

- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch Thick or Less: 1/16 inch (1.5 mm).
 - 2. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.
- D. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- E. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of water-resistant varnish.

2.6 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Quality Standard: Comply with AWI Section 300.
- B. Grade: Custom.
- C. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
- D. Assemble casings in plant except where limitations of access to place of installation require field assembly.
- E. Assemble moldings in plant to maximum extent possible. Miter corners in plant and prepare for field assembly with bolted fittings designed to pull connections together.
- F. Wood Species and Cut: Select white maple, plain sawn.

2.7 WOOD CABINETS AND SHELVING FOR TRANSPARENT FINISH

- A. Quality Standard: Comply with AWI Section 400 and additional specified requirements for wood cabinets.

- B. Grade: Custom.
- C. AWI Type of Cabinet Construction: Flush overlay.
- D. Wood Species and Cut for Exposed Surfaces: Select white maple, plain sliced.
 - 1. Grain Matching: Run and match grain vertically for doors and fixed panels.
 - 2. Matching of Veneer Leaves: Book match.
 - 3. Vertical Matching of Veneer Leaves: End match.
 - 4. Veneer Matching within Panel Face: Running match.
 - 5. Drawer Faces: Solid wood, grain run vertically.
 - 6. Open Shelving: 1-inch thick for all widths.
 - a. Edge Treatment: Solid wood matching face for species and cut; front and back.
- E. Semiexposed Surfaces: Provide surface materials indicated below:
 - 1. Surfaces Other Than Drawer Bodies: Match species and cut indicated for exposed surfaces.
 - 2. Drawer Sides and Backs: Solid-hardwood lumber, same species indicated for exposed surfaces.
 - 3. Drawer Bottoms: Hardwood plywood, same species indicated for exposed surfaces.
 - 4. Shelving: 3/4-inch thick for shelves up to 36 inches wide, 1-inch thick for shelves over 36 inches wide.

2.8 PLASTIC-LAMINATE CABINETS

- A. Quality Standard: Comply with AWI Section 400 and additional specified requirements for laminate cabinets.
- B. Grade: Custom.
- C. AWI Type of Cabinet Construction: Flush overlay.
- D. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 - 1. Horizontal Surfaces Other Than Tops: HGL.
 - 2. Vertical Surfaces: VGS.
 - 3. Edges: PVC tape, 0.018-inch (0.460-mm) minimum thickness, matching laminate in color, pattern, and finish.
- E. Materials for Semiexposed Surfaces: Provide surface materials indicated below:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS.
 - 2. Drawer Sides and Backs: Solid-hardwood lumber.
 - 3. Drawer Bottoms: Hardwood plywood.
- F. Base and Tall Cabinets: Bottoms and ends of cabinets, exposed backs, and tops of cabinets; 3/4-inch particleboard, plastic laminate faced on exposed surfaces, plastic laminate faced on semi-exposed surfaces.
 - 1. Backs of Cabinets: 3/8-inch plywood. Back mounted to side, bottom and top; inset 3/4-inch to conceal mounting rails. Tall cabinets shall have rails positioned at top and intermediate location. Base cabinet shall have rail positioned at the top.
 - 2. Mounting Rails: 3/4-inch thick, fastened to cabinet back on interior of cabinet or as indicated in details.

3. Cabinet Sub-Base: Separate and continuous (no cabinet body sides to floor), water resistant exterior grade plywood with concealed fastening to cabinet bottom. Ladder type construction of front, back, and intermediates to form a secure and level platform to which cabinets attach.
 4. Depth: Provide cabinets of the type indicated meeting the following:
 - a. Deep Cabinet: Minimum outside depth of 23 inches from wall to face of cabinet box, less the door (approximately 24 inches from wall to face of door).
 - b. Shallow Cabinet: Minimum outside depth of 13 inches from wall to face of cabinet box, less the door (approximately 14 inches from wall to face of door).
- G. Wall Cabinets: Ends of cabinets and exposed backs; 3/4-inch particleboard, plastic-laminate faced on exposed surfaces, plastic laminate faced on semi-exposed surfaces. Tops and bottoms of cabinets; 1-inch particleboard, plastic laminate faced.
1. Backs of Cabinets: 3/8-inch plywood, plastic laminate liner faced surfaces with balance sheet on concealed side. Back mounted to side bottom and top, inset 3/4 inch to conceal mounting rails. Cabinets shall have rails positioned at top and bottom location.
 2. Mounting Rails: 3/4-inch thick, fastened to back of cabinet on interior of cabinet or as indicated in details.
 3. Depth: Wall hung cabinets shall have a minimum outside depth of 13 inches from wall to face of cabinet box, less the door (approximately 14 inches from wall to face of door).
- H. Inside Corners: Construct cabinets and fillers at inside corners to allow for proper clearance and operation of drawers and doors.
- I. Drawer Fronts: 3/4-inch particleboard, plastic-laminate faced on exposed surfaces, plastic laminate faced on semi-exposed surfaces, applied to separate drawer body sub-front.
- J. Drawer Bodies: 1/2-inch thick MDF or plywood sides, back, and sub-fronts with dadoed, pinned and glued joints. MDF bottom, 1/4-inch thick, rabbeted into sides, back and sub-front, and glued. All surfaces inside and outside of drawer box shall be covered with plastic-laminate finish. Reinforce drawer bottoms with 1/2- by 4-inch front to back hardwood intermediate stiffeners, glued and fastened in place. Provide one stiffener for drawers to 24 inch width, two to 36 inch width and four to 48 inch width.
- K. Solid Doors: 3/4-inch thick particleboard or medium-density fiberboard, plastic-laminate faced on exposed surface, plastic laminate faced on semi-exposed surfaces.
- L. Dividers: 3/4-inch thick particleboard or medium-density fiberboard, plastic-laminate faced on exposed surface, plastic laminate faced on semi-exposed surfaces.
- M. Shelving: Particleboard or medium-density fiberboard meeting the following:
1. Open Shelving: 1-inch thick shelving for all widths, unless otherwise indicated. Top of shelves faced with plastic-laminate. Underside of shelves, plastic laminate faced.
 2. Behind Solid Doors: 3/4-inch thick for cabinets up to 24 inches wide. 1 inch thick shelving for cabinets greater than 24 inches wide. Plastic laminate faced.
 3. All shelving shall be adjustable. Fixed center shelf for tall units to prevent bowing of cabinet sides.

- N. Edgbanding: Color to match surfacing material. Finished edgbanding shall be uniform in color and sheen.
 - 1. Exposed and Semi-Exposed Shelving: 3 mm PVC applied to front edge. 1 mm PVC applied to back edge and both ends.
 - 2. Doors and Drawer Fronts: 3 mm PVC applied to perimeter, matching face laminate.
 - 3. Drawer Bodies: 1 mm PVC applied to all edges, semi-exposed and concealed locations (top, back and bottom edges).
 - 4. Cabinet Bodies: 1 mm PVC applied to all exposed and semi-exposed edges, matching face laminate.
 - 5. Dividers: 1 mm PVC.
- O. Colors, Patterns, and Finishes: As indicated in Interior Materials Legend.

2.9 SOLID-SURFACING-MATERIAL COUNTERTOPS

- A. Solid-Surfacing-Material Thickness: 3/4 inch.
- B. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
 - 1. Match color, pattern, and finish as indicated by manufacturer's designations for these characteristics.
- C. Fabricate tops in one piece with shop-applied backsplashes and edges, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
- D. Drill holes in countertops for plumbing fittings and soap dispensers in shop.

2.10 FLUSH WOOD PANELING

- A. Quality Standard: Comply with AWI Section 500A requirements for flush wood paneling.
- B. Grade: Custom.
- C. Wood Species and Cut: Select white maple, plain sliced.
- D. Matching of Adjacent Veneer Leaves: Slip match.
- E. Vertical Matching of Adjacent Veneer Leaves: End match.
- F. Veneer Matching within Panel Face: Balance match.
- G. Vertical Panel-Matching Method: End match.
- H. Panel Core Construction: Hardwood veneer-core plywood .
 - 1. Thickness: As indicated.
- I. Exposed Panel Edges: Applied solid-wood banding 1/2 inch thick by depth of panels, unless indicated otherwise.
- J. Assemble panels by gluing and concealed fastening.

- K. Fabrication: Complete fabrication, including assembly and finishing, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Cap exposed finish edges with same material as face.
 2. When necessary to cut and fit on site, provide materials with ample allowance for cutting, and provide trim for scribing and site cutting.
 3. Apply veneer in full, uninterrupted sheets. Fit corners and joints hairline; secure with concealed fasteners.
 4. Apply balance sheet to reverse side of veneered finish surfaces.

2.11 SHOP FINISHING

- A. Quality Standard: Comply with AWI Section 1500, unless otherwise indicated.
1. Grade: Provide finishes of same grades as items to be finished.
- B. General: Shop finish transparent finished interior architectural woodwork at fabrication shop as specified in this Section. Refer to Division 09 Section "Painting" for finishing opaque finished architectural woodwork.
- C. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative overlay.
- D. Transparent Finish: Comply with requirements indicated below for grade, finish system, staining, and sheen, with sheen measured on 60-degree gloss meter per ASTM D 523:
1. Grade: Same as item being finished.
 2. AWI Finish System: Catalyzed polyurethane.
 3. Staining, WS1: Match Architect's sample, see materials legend.
 4. Filled Finish for Open-Grain Woods: After staining, apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
 - a. Apply vinyl wash coat sealer after staining and before filling.
 5. Sheen: Satin, 30-50 gloss units.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Condition woodwork to average prevailing humidity conditions in installation areas before installation.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

- A. Quality Standard: Install woodwork to comply with AWI Section 1700 for the same grade specified in Part 2 of this Section for type of woodwork involved.
- B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces and repair damaged finish at cuts.
- D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- E. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
 - 1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base, if finished.
 - 2. Install wall railings on indicated metal brackets securely fastened to wall framing.
 - 3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.
- F. Cabinets and Casework: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c.
- G. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
 - 4. Install countertop brackets specified in Part 2. Painting of bracket specified in Division 09 Section "Painting."
 - 5. Provide cutouts for plumbing fixtures and fittings. Verify locations of cutouts from on-site dimensions. Seal surfaces of cutout edges.
 - 6. Caulk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

- H. Veneer Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels.
 - 1. Install paneling with no more than 1/16 inch in 96-inch vertical cup or bow and 1/8 inch in 96-inch horizontal variation from a true plane.
 - 2. Conceal fasteners to greatest practical extent.
 - 3. Arrange panels with joints over supports. Fasten to supports with nails of type and at spacing recommended by panel manufacturer.

- I. Shelving and Clothes Rods:
 - 1. Cut shelf cleats at ends of shelves about 1/2 inch less than width of shelves and sand exposed ends smooth.
 - 2. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches o.c. Use 2 fasteners at each framing member or fastener location for cleats 4 inches nominal in width and wider.
 - a. Apply a bead of multipurpose construction adhesive to back of shelf cleats right before installing. Remove adhesive that is squeezed out immediately after fastening shelf cleats in place.
 - 3. Install rod flanges for rods as indicated. Fasten to shelf cleats, framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Install rods in rod flanges.

- J. Shelving on Brackets and Standards:
 - 1. Install shelf brackets according to manufacturer's written instructions, spaced not more than 30 inches o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
 - 2. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 30 inches o.c. and within 6 inches of end of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Space fasteners not more than 12 inches o.c.
 - 3. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.
 - a. Fasten shelves to cleats with finish nails or trim screws, set flush.
 - b. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.

- K. Complete the finishing work specified in this Section to extent not completed at shop or before installation of woodwork. Fill nail holes with matching filler where exposed. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats were applied in shop.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

3.4 PROTECTION

- A. Provide final protection and maintain conditions in a manner acceptable to fabricator and Installer that ensures that woodwork is without damage or deterioration at time of Substantial Completion.

END OF SECTION 064000

SECTION 072100 - BUILDING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Foam-plastic board insulation.
2. Spray urethane foam insulation.
3. Foam-in-place insulation sealant.
4. Insulation in frames of steel doors.
5. Z- and J-furring and rigid insulation at exterior walls.

B. Related Sections:

1. Division 05 Section "Cold Formed Metal Framing" for cold formed metal framing and gypsum sheathing to receive air/vapor barrier beneath rigid insulation.
2. Division 07 Section "Clay Panel Wall Cladding System" for wall cladding system installed on Z-furring.
3. Division 07 Section "Under-Slab Vapor Retarders."
4. Division 07 Section "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing" for insulation specified as part of low-slope roofing construction.
5. Division 07 Section "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.
6. Division 09 Section "Gypsum Board Assemblies" for provision in metal-framed assemblies of acoustical insulation.
7. Divisions 22 and 23 Sections for insulation on ducts, piping, and equipment.

1.3 DEFINITIONS

- A. Thermal Resistivity: Where the thermal resistivity of insulation products are designated by "r-values," they represent the reciprocal of thermal conductivity (k-values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- C. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency and bearing UL label. Identify products with appropriate markings of applicable testing agency.
- C. Mockups: Build mockups to set quality standards for installation.
 - 1. Prepare mockup for review at Preinstallation Conference.
 - 2. Build mockup of typical wall assembly on one leg of exterior framed wall mockup constructed in Division 05 Section "Cold-Formed Metal Framing." Mockup shall include wall insulation and Z-furring in specified thicknesses prepared for installation of wall cladding system.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.
- C. Storage Requirements for Spray Urethane Foam Insulation: 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. Store materials covered, out of direct sunlight, and at temperatures between 60 deg F and 70 deg F.
 - 1. Dispose of empty containers by technicians in accordance with manufacturer's recommendations, current law, and industry standard practice.

1.7 PROJECT CONDITIONS FOR SPRAY URETHANE FOAM INSULATION

- A. Environmental Limitations: Do not apply material when ambient or substrate temperature is 50 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application. Do not apply material when moisture due to dew, frost or water is present on substrate materials.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE Retain types of insulation required in insulation articles below. Coordinate selections with thicknesses and thermal resistances indicated on Drawings and with HVAC design and energy program.

2.2 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

- A. Under Slab and Foundation Perimeter Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 25 psi, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
1. Edge Condition: As follows:
 - a. Under Slab Insulation: Square edge.
 - b. Perimeter Insulation: Tongue and groove or shiplap edges.
 2. Thickness: 2 inch, unless indicated otherwise.
 3. Products: Provide one of the following products:
 - a. Styrofoam; Dow Chemical Company (The).
 - b. Foamular 250; Owens Corning.
 - c. GreenGuard; Pactiv Building Products.
- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.3 POLYISOCYANURATE FOAM-PLASTIC BOARD

- A. Rigid Insulation for Installation in Z-Furring and at Window Blocking: ASTM C1289 Type 1, Class 2, closed-cell polyisocyanurate foam insulation faced with 10.5 mil thick glass fiber reinforced foil facer on each side, exposed side shall have a 1.5 mil thick reflective aluminum facer and meeting the following physical properties:
1. Density: ASTM D 1622, nominal 2.0 pcf.
 2. Compressive Strength: ASTM D1621, 20 psi, minimum.
 3. Water Absorption: ASTM C209, less than 0.1 percent by volume.
 4. Air Permeance: ASTM E 2178, less than 0.02l/ssm.
 5. Board Size and Configuration:
 - a. Panel Size: 2 feet by 12 feet long.
 - b. Thickness: 3 inches.
 - c. Edge Condition: Square.
 6. Thermal Resistance: R-20.3.
 7. Fire Performance: Shall be compliant with NFPA 285 and UL 1715.
 8. Fire-Test-Response Characteristics: ASTM E 84, maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
 9. Product: Rmax Operating, LLC; TSX-8500.

2.4 SPRAY URETHANE FOAM INSULATION

- A. Spray Urethane Foam Insulation: Closed-cell polyurethane insulation, ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84; with non-ozone depleting blowing agent.
1. Density: ASTM D 1622; minimum density of 2.0 lb/cu. ft.
 2. Thermal Resistivity (R-Factor), LTTR: Not less than 6.4 per inch of thickness.
 3. Closed Cell Content: ASTM D 2856, 90 percent minimum.

4. Vapor Permeance: ASTM E 96, 1-inch thickness, 1.2 perms maximum.
5. Fungi Resistance: ASTM C 1338, no growth.
6. Applied Thickness: 3" in exterior stud cavity.
7. Products:
 - a. JM Corbond III SPF; Johns Manville Corporation.
 - b. CertaSpray Closed Cell Foam; CertainTeed Corporation.
 - c. Heatlok Soy; Demilec LLC, Arlington, TX.
 - d. Icynene MD-C-200; Icynene Inc.

2.5 FOAM-IN-PLACE INSULATION SEALANT

- A. Foam-In-Place Insulation Sealant, General Use: On-site foam-in-place insulation shall be Class 1 foam.
 1. Products:
 - a. Froth-Pac; Dow Chemical Company (The).
 - b. Touch 'n Foam Gun Foam Sealant; Convenience Products.
- B. Polyurethane Foam Insulation Sealant (Minimal Expansive) for Perimeters of Openings in Exterior Walls: Single- or two-component, UL classified sealant, to insulate, seal, fill, and stop air infiltration; shall not expand to the point to cause pressure on jambs of opening in exterior walls.
 1. Density: ASTM D 1622, 1.0 - 1.8 lbs./cu. ft.
 2. R-Value: ASTM C 518, not less than 4.0 per inch of thickness.
 3. Fire-Test-Response Characteristics: ASTM E 84, as follows:
 - a. Flame Spread: Not greater than 25.
 - b. Smoke Developed: Not greater than 50.
 4. Products:
 - a. Dow Chemical Company (The); Great Stuff PRO Window & Door.
 - b. Fomo Products Inc.; Handi-Seal Window and Door Sealant.
 - c. Convenience Products; No-Warp Foam Window & Door Insulating Sealant.

2.6 METAL FURRING

- A. Steel Sheet Components: Complying with ASTM A 1003/A 1003M, Structural Grade, Type H, G90 metallic coating.
- B. Z-Shaped and J-Shaped Furring: Nonslotted web, face flange width of 1-1/4 inches, wall attachment flange width of 7/8 inch, bare metal thickness of not less than 0.053-inch (16 gage), and depth required to fit insulation thickness indicated.
- C. Screws for Fastening Furring to Cold-Formed Metal Framing: Steel drill screws, in sufficient length required to penetrate gypsum sheathing and into framing with not less than 3 full threads. Screws shall be stainless steel or have organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.
- B. Preparation for Spray Urethane Foam Insulation:
 - 1. Mask and cover items not indicated to receive insulation, protecting from fallout or overspray of materials during application.
 - 2. Brush down roof deck, adjacent eave framing, and substrates to loosen and remove cobwebs, dirt, dust and debris. Upon completion of brush-down, blow surfaces clean with compressed air to remove remaining surface dust and dirt. Upon completion of operations, substrate shall be clean of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated. Butt joints tight and fasten in place to prevent displacement during the installation of work that conceals insulation. Fill voids in thermal envelope not covered by the work of other sections.
 - 1. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with installation of insulation.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

- A. On vertical footing and foundation wall surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. Extend insulation to top of footing, unless otherwise indicated.
 - 2. Seal end-to-end joints between units by applying sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with sealant as recommended by insulation manufacturer.
- B. On horizontal surfaces under slabs, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 - 1. Extend insulation a minimum of 48 inches in from exterior walls.

3.4 INSTALLATION OF METAL FURRING AND RIGID INSULATION

- A. Install rigid insulation and hold in place with Z-furring members spaced 24 inches o.c. Fasten Z-furring members securely through gypsum sheathing into cold-formed steel framing; provide two #10 screws per stud.
- B. Protect rigid insulation from exposure to sunlight by immediately installing wall sheathing provided in Division 06 Section "Rough Carpentry."

3.5 INSTALLATION OF SPRAY URETHANE FOAM INSULATION

- A. General: Apply spray-applied foam insulation in accordance with manufacturer's written instruction. Apply in consecutive passes as recommended by the manufacturer to achieve specified thickness.
 - 1. To prevent foam shrinkage and separation from exterior framing members, verify that proper catalyst is being used for temperature conditions. Maintain two part foam components at proper temperature in canisters and hose to nozzle tip.
 - 2. Apply foam at proper rate and thickness to assure foam does not overheat during curing.

3.6 INSTALLATION OF FOAM-IN-PLACE INSULATION SEALANT

- A. Install foam-in-place insulation sealant to a minimum depth of 1inch, sealing roof deck flutes and construction cracks and gaps where outside air and cold can infiltrate, providing an airtight building envelope.
- B. Seal around wires running through top and bottom plates in exterior walls, and through the top plates of top story walls with cold attic spaces above. Seal around all penetrations into cold attic spaces including conduits, pipes, vents and other items penetrating thermal barriers and vapor barriers.

3.7 INSULATING STEEL DOOR FRAMES

- A. Exterior Frames: Steel door frames in exterior steel-framed walls shall be filled with rigid insulation. Cut rigid insulation slab the full width of frame throat and insert continuous slab into door frame head and jambs before frame is installed.
 - 1. After frame is installed, fill remaining gap between rigid insulation and air/vapor barrier with foam-in-place insulation.
 - 2. Foam remaining gaps with minimal expanding foam.

3.8 CLEANING

- A. Cleaning after Installation of Stray Polyurethane Foam Insulation: Remove material overspray, and protection materials from surfaces of other construction and clean exposed surfaces. Remove trash and debris from the project site and properly dispose of.

3.9 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse

and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

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SECTION 072300 - UNDER-SLAB VAPOR RETARDERS

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. Vapor retarder under slabs-on-grade.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Samples for Verification: 12-inch square units for each type of vapor retarder indicated.

1.4 QUALITY ASSURANCE

- A. Mockup: Construct a mock-up at an approved location of the vapor barrier installation, including taping of seams, perimeter seal and attachment, and sealing of penetrations.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 VAPOR RETARDERS FOR UNDER SLABS

- A. Vapor Retarder: ASTM E-1745, meeting or exceeding Class B and having the following qualities:
 - 1. Maximum Permeance: ASTM F 1249, not greater than 0.01 perms.
 - 2. Tensile Strength: ASTM E154 or D638, Class A – over 45 lbf/in.
 - 3. Puncture Resistance: ASTM E-154, Class B – over 1700 grams.
 - 4. Water Vapor Barrier: ASTM E-1745, meets or exceeds Class B.
 - 5. Thickness of Barrier (Plastic): ACI 302.1R-96, not less than 15 mils.
 - 6. Products: Subject to compliance with requirements, provide one of the following products:
 - a. Stego Wrap; Stego Industries LLC, (877) 464-7834.

- b. Vaporguard; Reef Industries.
 - c. Perminator Underslab Vapor-Mat; W.R. Meadows, Inc.
- B. Tape: High-density polyethylene tape with rubber-based pressure sensitive adhesive. Minimum 4-inch width. Provide cold weather tape for low temperature applications.
- C. Mastic: Medium viscosity, polymer-modified anionic bituminous/asphalt emulsion.
- D. Pipe Boot: Construct boots from vapor retarder material and high-density polyethylene tape per manufacturer's instruction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.
- 1. Confirm granular base is level, properly rolled or tamped, and ready to receive vapor retarder.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances harmful to vapor retarders, including removing projections capable of puncturing vapor retarders, or of interfering with attachment.

3.3 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions applicable to products and application indicated.
- B. Extend retarders in thickness indicated to envelop entire area to be covered. Cut and fit tightly around obstructions. Remove projections that interfere with placement.

3.4 INSTALLATION OF UNDER-SLAB VAPOR RETARDERS

- A. Install vapor retarder under all interior floor slabs in strict accordance with the manufacturer's printed instructions and as follows:
- 1. Place vapor retarder with the longest dimension parallel with the direction of the pour.
 - 2. Snap chalk line along inside perimeter of foundation walls at top of slab elevation.
 - 3. Without wetting, clean a 3-inch wide band on the surface of the concrete below the chalk line at approximately mid-slab height. Remove dirt, residual form release, or other bond inhibiting surface contaminants. Grind smooth any surface projections within the band.
 - 4. Lap vapor retarder on to perimeter foundation walls and vertical surfaces, sealing with continuous 1-1/2 inch wide bed of mastic.
 - 5. Lap joints 6 inches and seal with polyethylene tape.

6. Seal pipe penetrations with pipe boot made from vapor barrier and tape, or mastic per manufacturer's detail requirements.
7. Install vapor retarder beneath all slabs on ground, including radiant heated slabs with under slab insulation.
8. Repair damaged areas by cutting patches of vapor retarder, overlapping damaged area 6 inches and taping all four sides with polyethylene tape.

3.5 PROTECTION

- A. Protect installed vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where vapor retarders are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072300

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SECTION 072726 - FLUID-APPLIED AIR/VAPOR BARRIER SYSTEM

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. A fluid-applied air/vapor barrier system.
- B. Related Sections include the following:
 - 1. Division 05 Section "Cold Formed Metal Framing" for wall sheathings.
 - 2. Division 07 Section "Joint Sealants" for joint-sealant materials and installation.

1.3 PERFORMANCE REQUIREMENTS

- A. Air/Vapor Barrier: Shall be designed and constructed as a continuous air barrier to control air leakage into, or out of the conditioned space, and to act as a watertight barrier to discharge to the outside any incidental condensation or water penetration. Air/vapor barrier membrane shall accommodate movements of building materials by providing expansion and control joints as required, with appropriate air seal materials at such locations, changes in substrate and perimeter conditions. Barrier shall be continuous with all joints made air-tight and shall have the following characteristics:
 - 1. Tensile Strength: ASTM D 412, 119 psi.
 - 2. Elongation: ASTM D 412, not less than 800 percent.
 - 3. Air Permeability: ASTM E 2178 & ASTM E 283: Shall not exceed 0.0012 cfm/sq.ft. at 1.57lbs/sq.ft.
 - 4. Water Vapor Permeance: ASTM E 96, Method B, not more than 0.08 perms.
 - 5. Surface Burning: ASTM E 84, flame spread index not more than 25 and smoke generation index not more than 450.
 - 6. Peel Strength, to Dry Concrete: ASTM C 836, 3319 lbf/ft.
 - 7. Long Term Flexibility: Pass to CGSB 71-GP-24M.
 - 8. Resistance to Mold, Mildew & Fungal Growth: ASTM D 5590, no growth.
 - 9. Fire Testing: Shall comply with NFPA 285 in various wall assemblies.
 - 10. Shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on envelope without damage or displacement; shall transfer load to structure; and shall not displace adjacent materials under full load.
 - 11. Shall be joined in an airtight, flexible manner to the air barrier surface/material of adjacent systems, allowing for relative movement of systems due to thermal and moisture variations or creep. Air/vapor barrier shall be connected to the following system components:
 - a. Foundation and walls.
 - b. Doors penetrating exterior walls.
 - c. Aluminum-framed entrances, storefronts and curtain walls.
 - d. Different wall systems.

- e. Wall and roof intersections.
 - f. Wall and floor assemblies spanning control joints.
 - g. Wall penetrations by miscellaneous metals, ties, screws, bolts and similar items.
 - h. Wall, floor and roof penetrations by pipes, ducts and conduits.
- B. Air/Vapor Barrier Penetrations: All penetrations of the air/vapor barrier and paths of air infiltration or exfiltration shall be made airtight to not less than the rating of the air/vapor barrier.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Complete Shop Drawings and Product Data shall be submitted to the Architect at least 21 days before the Preinstallation Conference. No Preinstallation Conference will be held and no material shall be applied until submittals are complete and released for construction.
- C. Product Data: For each type of product indicated. Include technical data; certified test results; manufacturer's printed instructions for evaluating, preparing and treating substrate; and installation instructions, including temperature and other limitations of installation.
1. Include manufacturer's list and description of wall assemblies, incorporating product, approved per NFPA 285.
- D. Shop Drawings: Show locations and extent of air/vapor barrier and details of intersections with other envelope systems and materials; details of membrane counter-flashings; details for construction of inside and outside corners; and details showing how expansion and control joints will be bridged. Identify materials, primers, sealers, support materials and other items detailed, including manufacturer's product names. Show relationship to adjacent materials, sequence of installation and materials, and methods for sealing penetrations. Shop drawing shall include connection details between the air/vapor barrier and for the following exterior envelope components as applicable to the project:
1. Foundations and walls.
 2. Doors.
 3. Aluminum-framed entrances, storefronts and curtain walls.
 4. Wall and roof assemblies.
 5. Wall penetrations by pipes, ducts and conduits.
 6. Typical gypsum based sheathing joint treatment, outside corner, inside corner.
 7. Square tube, steel angle, channels, knife plates, structural WF beam and tube shape penetration sealing as applicable.
 8. Detailing a penetration where gypsum sheathing has a wide gap from the penetration.
 9. Through-wall flashing attachment to sprayed surfaces. Proper surface prep and installation requirements.
 10. Through-wall flashing with proper support across cavity, including what is acceptable gap width. Typical at lintel angles and relieving angles.
 11. Horizontal deflection joint and vertical control joint details in gypsum based sheathing, CMU, and plywood substrates, as applicable.
 12. Corner and edge damage preparation of gypsum based sheathing (sheet metal cover plate adhered to board) to receive A/V barrier membrane.
 13. Hollow metal door frames, mechanical louvers and vent penetrations.

- E. Product Certificates: For air/vapor barrier system, certifying compatibility of air/vapor barrier system and accessory materials with Project materials that connect to or that come in contact with the air/vapor barrier system; signed by product manufacturer.
- F. Qualification Data: For Installer signed by manufacturer certifying that Installers comply with requirements.
- G. Product Test Reports: From a qualified independent testing agency indicating and interpreting test results of air/vapor barrier system for compliance with requirements, based on comprehensive testing of current air/vapor barrier system in accordance with ASTM E 2178.
- H. Daily Reports: Installer shall maintain daily reports at the Project site. Copies of reports shall be submitted weekly.
- I. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Shall meet the following requirements:
 1. Shall be factory trained and approved in writing by air/vapor barrier membrane manufacturer.
- B. Mockups: Provide mockups of the air/vapor barrier system applied to gypsum sheathing substrate.
 1. Air/Vapor Barrier Mockup Panel: Apply air/vapor barrier membrane mockup to exterior wall assembly built in Division 05 Section "Cold-Formed Metal Framing." Mockup panel will be left exposed to show connections between wall and foundation, and through-wall flashings, showing relationship of materials with air/vapor barrier membrane and quality of workmanship. Mockup shall also demonstrate surface preparation, crack and joint treatment, and sealing of gaps, terminations, and penetrations of air/vapor barrier membrane.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, unless such deviations are specifically approved by Architect in writing.
 3. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air/vapor barrier until mockups are approved.
 4. Complete mockup for review at preinstallation conference.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to air/vapor barrier membrane installation.
 1. Complete Shop Drawings and Product Data shall be submitted to the Architect at least 21 days before the Preinstallation Conference.
 2. Meet with Owner, Architect, air/vapor barrier membrane Installer, air/vapor barrier membrane system manufacturer's representative, testing agency representative, and installers whose work interfaces with or affects air/vapor barrier membrane including, but not limited to, installers of exterior sheathing, exterior wall assemblies, storefront and curtain wall assemblies, door assemblies, roofing assemblies, and flashings and trim.
 3. Review air/vapor barrier requirements including surface preparation, substrate condition and pretreatment, minimum substrate curing period, forecasted weather conditions,

special details and sheet flashings, mockups, installation procedures, sequence of installation, testing and inspecting procedures, and protection and repairs.

4. Review approved submittals.
5. Review mock-ups.
6. Review methods and procedures related to air/vapor barrier membrane installation, including manufacturer's written instructions, including surface preparation and substrate condition and pretreatment, if applicable.
7. Review how mil thickness of applied material will be measured during application, to maintain specified thickness.
8. Review compatibility of air/vapor barrier materials with building envelope materials.
9. Review interface of flashings and trim with air/vapor barrier system.
10. Review and coordinate sequence of installation with adjacent materials.
11. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
12. Review cold formed metal framing and sheathing installation report.
13. Review construction schedule for subsequent work covering air/vapor barrier.
14. Review procedures for quality assurance, testing, and corrective procedures.
15. Review daily report and air testing requirements.
16. Review coordination of inspection of exterior air/vapor barrier before covering.
17. Review coordination of inspection of interior side of sheathing for holes before interior finishes are applied.
18. Review procedures for correcting holes made by screws missing framing during application of wall ties, z-furring, and other applicable wall attachments.
19. Review requirements for exterior insulation being in place before heating of building interior.
20. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
21. Provide 5 business days minimum advance notice to participants prior to convening preinstallation conference.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Protect materials from damage from sunlight, weather, freezing, excessive temperatures, and construction operations. Store liquid materials at temperatures of not less than 40 deg F. Remove damaged material from site and replace at no additional cost to Owner.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Comply with the manufacturer's written instructions for proper material storage and handling.
- E. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted temperature and humidity conditions permit air/vapor barrier membrane to be installed according to manufacturers' written instructions and requirements.
 - 1. Do not apply air/vapor barrier system in snow, rain, fog, or mist.
- B. Environmental Conditions: Apply air/vapor barrier materials within the range of ambient and substrate temperatures recommended by air/vapor barrier manufacturer. Do not apply air/vapor barrier system to a damp or wet substrate.
- C. Maintain adequate ventilation during preparation and application of air/vapor barrier materials.

1.8 DAILY REPORTS

- A. Installer shall maintain daily reports of all air/vapor barrier installation activity. As a minimum, report shall contain the following:
 - 1. Weather conditions, temperature.
 - 2. Substrate condition, defects and corrective action.
 - 3. Identify area of building where application took place.
 - 4. List of certified installers at the site.
 - 5. Identify applicators operating the spray gun.
 - 6. Temperature at time of application and cure time of primers before application of membrane.
 - 7. Temperature at time of spray application of air/vapor membrane.
 - 8. Measurements of film thickness. Provide measurement for not less than one measurement per 1000 square feet.
 - 9. Photos of installed areas.

1.9 CONTRACTOR FIELD TESTING

- A. Membrane Thickness: Applicator shall continually monitor application thickness with wet film gage.

1.10 COORDINATION

- A. Coordinate installation of air/vapor barrier system with the schedule of temporary heating of the building. Air/vapor barrier system shall be fully covered by exterior insulation before heat is turned on within building.

1.11 WARRANTY

- A. General: Special warranties specified in this Section shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer's System Warranty: Written system warranty, signed by air/vapor barrier manufacturer agreeing to replace air/vapor barrier system materials and accessories which fail

to achieve specified air tightness and vapor seal, exhibit loss of adhesion or cohesion, or do not cure within specified warranty period.

1. Warranty Period: Manufacturer's standard warranty, not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FLUID-APPLIED AIR/VAPOR BARRIER SYSTEM MATERIALS

- A. Single Source Responsibility: Obtain air/vapor barrier materials, including transition taps, sealant, primers, mastics and adhesives, from a single manufacturer for a complete assembly.
- B. Fluid-Applied Air/Vapor Barrier Membrane: Provide fluid-applied membrane and accessory products of inherent, fire-resistant composition complying with NFPA 285 for use as an air/vapor barrier in exterior walls.
 1. Basis-of-Design: Subject to compliance with requirements, provide Air-Bloc 32MR manufactured by Henry Company, Contact - Scott Walker 978-317-9521, or the following product:
 - a. Carlisle Coatings and Waterproofing, Inc.; Fire Resist Barritech NP.
- C. Detail Flashing Strip/Transition Strip: Self-adhering, membrane strip, not less than 3 inches wide, approved for use with fire-resistant air barrier membrane in NFPA 285 wall assemblies and as recommended by air barrier manufacturer.
- D. Transition Strip Between Air/Vapor System and EPDM Membrane Roofing: 30 mils thick minimum, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl rubber adhesive, with a disposable silicone-coated release-paper backing; cold applied.
- E. Primer: Water-based liquid primer for concrete, masonry, gypsum sheathing, wood, metal, and painted substrates as recommended by air/vapor barrier system manufacturer for application indicated.
- F. Transition Strip Primer: Water-based liquid primer for application indicated.
- G. Mastic, Adhesives, and Tape: Liquid mastics, adhesives, and tapes as recommended by air/vapor barrier manufacturer for indicated applications.
- H. Concrete Conditioner: Latex-based, water-dispersible liquid for concrete substrate preparation applied before application of self-adhered membranes and tapes.
- I. Termination Mastic: Two part, elastomeric, cold-applied, trowel grade material designed for use with self-adhered membranes and tapes; 100 g/l maximum VOC content.
- J. Sealants: Provide in accordance with Division 07 Section "Joint Sealants" and ASTM C 920 classifications for type, grade, class, and uses.
 1. Silicone Sealant: Single component, neutral curing, low modulus.
 - a. Location: To seal sheet membrane flashing to polyethylene face of sheet rubberized-asphalt barrier and to seal between and to non-bituminous sheet systems.
 - b. Products:

- 1) Dow Corning Corporation; Dow 790.
 - 2) GE Advanced Materials - Silicones; SilPruf or SilPruf LM.
 - 3) Pecora Corporation; 890, 891 or 895 Silicone Sealant.
2. SPF (Sprayed Polyurethane Foam) Sealant: Provide one- or two-component, foamed-in-place, polyurethane foam sealant with the following characteristics:
- a. Density: 1.5 to 2.0 PCF.
 - b. Flame Spread (ASTM E162): 25 or less.
 - c. Initial R-Value (at 1 inch): Not less than 7.
 - d. Products:
 - 1) Dow Chemical Co.; Great Stuff PRO Window & Door.
 - 2) Fomo Products Inc.; Handi-Seal Window and Door Sealant.
 - 3) Convenience Products; No-Warp Foam Window & Door Insulating Sealant.

K. Detailing Metal: 0.032 inch thick aluminum sheet.

2.2 EQUIPMENT

A. Sprayer: Airless spray equipment approved by air/vapor barrier manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions as each area is completed for air/vapor barrier system application, with Installer present, to verify that surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants that are detrimental to the adhesion of air/vapor barrier system materials.
1. Concrete Substrates: Verify that concrete has cured and aged for minimum time period recommended by air/vapor barrier system manufacturer; that concrete is visibly dry and free of moisture; and that concrete surfaces are smooth without large voids, spalled areas or sharp protrusions.
 - a. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 2. Masonry Surfaces: Verify that masonry joints are flush and completely filled with mortar, and all excess mortar sitting on masonry ties has been removed.
 3. Gypsum Sheathing: Verify that boards are sufficiently stabilized with corners and edges fastened with appropriate screws at proper spacing.
 4. If unacceptable conditions are encountered, prepare written report, endorsed by Applicator, listing conditions detrimental to performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air/vapor barrier membrane application.
- B. Mask off adjoining surfaces not covered by air/vapor barrier system to prevent spillage and overspray affecting other construction.

- C. Concrete Substrates:
1. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
 2. Prime with conditioning primer when installing modified asphalt membrane transition membranes. Apply primer at required rate and allow to dry. Limit priming to areas that will be covered by air/vapor barrier in same day. Reprime areas exposed for more than 24 hours.
- D. Concrete Joint Treatment: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air/vapor barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
1. Seal cracks over 1/16 inches in masonry and concrete with a strip of self-adhering transition membrane lapped a minimum of 1-1/2 inches on both sides of the crack.
 - a. Prime surfaces as per manufacturers' instructions and allow to dry.
 - b. Align and position self-adhering transition membrane, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of membrane.
 - c. Roll all laps and membrane with a counter top roller to ensure seal.
 2. Prime substrate and apply a single thickness of preparation coat strip extending a minimum of 3 inches along each side of joints and cracks. Apply a double thickness of air barrier membrane and embed a joint reinforcing strip in preparation coat.
- E. Gypsum Sheathing Panels:
1. Seal joints 1/4-inch or less between panels with manufacturer approved joint treatment sealant ensuring contact with all edges of board. Strike flush any excess sealant over joint layer to form a continuous layer over the joint.
 2. Seal gaps and voids or irregular joints greater than 1/4-inch between panels with a strip of self-adhered air barrier transition membrane lapped a minimum of 1-1/2 inches on both sides of the joint.
 - a. Prime surfaces as per manufacturers' instructions and allow to dry.
 - b. Align and position self-adhering air barrier transition membrane, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of membrane.
 - c. Roll all laps and membrane with a counter top roller to ensure seal.
 3. Inside and Outside Corners: Seal inside and outside corners of sheathing boards with a strip of self-adhering transition membrane extending a minimum of 3 inches on each side of the corner detail.
 - a. Prime surfaces as per manufacturers' instructions and allow to dry
 - b. Align and position self-adhering transition membrane, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of membrane.
 - c. Roll all laps and membrane with a counter top roller to ensure seal.
- F. Prime wood, metal, and painted substrates with primer recommended by membrane manufacturer.

- G. Fill gaps between different substrate systems to form a smooth transition from one plane to another; fill gaps between substrates and storefront systems, and curtain wall systems; and fill miscellaneous penetrations in substrates with sealant.
 - 1. Apply foam sealant in gaps up to 2 inches wide.
 - 2. Apply insulation foam sealant in gaps greater than 2 inches wide.
 - 3. Cover sealants with aluminum sheet metal or other substrate material approved by the air/vapor barrier manufacturer, providing a permanent air/vapor barrier transition attachment.
 - 4. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- H. Bridge and cover control joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips.
 - 1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- I. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air/vapor barrier system and at protrusions according to air/vapor barrier system manufacturer's written instructions.

3.3 INSTALLATION, GENERAL

- A. Strictly comply with air/vapor barrier membrane manufacturer's printed instructions, approved submittals and the following:
 - 1. Apply materials within manufacturer's requirements for temperature and weather conditions.
 - 2. Do not apply to wet or frozen substrates.
 - 3. Do not allow contamination with dust or dirt.
 - 4. Seal completely at edges, perimeter and penetrations.
 - 5. Wrap membrane around perimeter of openings for storefront and curtain wall systems, so the storefront and curtain wall systems can be caulked around the interior perimeter of the opening, sealing between edge of storefront/curtain wall system and air/vapor barrier membrane.
 - 6. Dry film thickness shall be not less than specified.
- B. Spray apply air/vapor membrane using airless spray equipment. Use cross-hatching technique (alternating horizontal and vertical passes) to ensure complete coverage of substrate and transition strips and even thickness of air/vapor barrier. Seal to penetrations to achieve an airtight envelope.
- C. Treat construction joints and install flashings as recommended by manufacturer.

3.4 FLUID-APPLIED AIR/VAPOR BARRIER SYSTEM INSTALLATION

- A. Apply air/vapor barrier in a continuous, uniform film using multiple, overlapping passes to achieve a dry film thickness not less than 60 mils thickness.
- B. Inspect sprayed surfaces and fill any remaining gaps.
- C. Application of Transition Membrane:

1. Allow spray-applied membrane to cure to tack-free. Apply transition membrane with an overlap of not less than 3 inches onto each surface at all beams, columns and joints as indicated in detail drawings and on approved Shop Drawings.
 2. Tie in to storefront framing, curtain wall systems, spandrel panels, roof and floor intersections and changes in substrate.
 3. Use pre-cut, easily handled lengths for each location.
 4. Remove release paper and position flashing carefully before placing it against the surface. Install membrane in tight intimate contact with substrate without stretching. Bend membrane to fit tightly into inside corners, without gaps and without stretching membrane.
 5. When properly positioned, place against surface by pressing firmly into place with a hand roller.
 6. Overlap adjacent pieces not less than 2 inches and roll all seams with a hand roller.
 7. Seal top edge of transition membranes and flashing with termination mastic.
 8. Apply liquid membrane to all fastener heads, overlapping board not less than 1 inch.
- D. Transition Strip Flashing to Door Frames, and Storefront and Curtain Wall Perimeters: Prime all surfaces in accordance with recommendations of air/vapor barrier manufacturer. Lap transition strip from wall substrate with not less than 3 inches of full contact over firm bearing to penetration frame with not less than 1 inch of full contact.
1. Apply primer to substrates at required rate and allow to dry thoroughly. Adjust time for drying, based upon ambient temperature, humidity and weather conditions. Limit priming to areas that will be covered by air/vapor barrier sheet in same day. Reprime areas exposed for more than 24 hours.
 2. Secure rubberized asphalt membrane flashings to substrates, membrane, and frames using roller to assure proper adhesion. Seal head, jamb and sill flashing at door perimeters, and aluminum storefront and curtain wall perimeters, making permanently weather tight.
 3. Set extruded preformed silicone flashings in full bed of low modulus silicone sealant.
- E. Transition Areas: Tie-in to structural beams, columns, floor slabs and intermittent floors, parapet curbs, foundation walls, roofing systems and at the interface of dissimilar materials as indicated in approved shop drawings with self-adhering air barrier transition membrane.
1. Prime surfaces as per manufacturer's instructions and allow to dry.
 2. Align and position self-adhering transition membrane, remove protective film and press firmly into place. Provide minimum 3 inch lap to all substrates.
 3. Ensure minimum 2 inch overlap at all end and side laps of membrane.
 4. Roll all laps and membrane with a counter top roller to ensure seal.
- F. At base of walls, apply air/vapor barrier to seal transition between top of foundation and wall. Apply air/vapor to back and bottom of brick shelves, stopping barrier 1 inch back from outside face of foundation wall.
- G. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

3.5 APPLICATION OF TERMINATION SEALANT

- A. Seal membrane terminations, heads of mechanical fasteners, masonry tie fasteners, around penetrations, duct work, electrical and other apparatus extending through the primary water resistive air barrier membrane and around the perimeter edge of membrane terminations at window and door frames with specified termination sealant.

3.6 FIELD QUALITY CONTROL

- A. Third Party Testing Agency: Owner will engage a qualified, independent testing and inspecting agency to perform field tests and inspections, and to prepare test reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections and tests.
 - 1. Air/vapor barrier system shall be tested for air infiltration and bond adhesion in compliance with requirements.
 - 2. Cooperate and coordinate with the Owner's inspection and testing agency.
- B. Remove and replace applications of air/vapor barrier membrane where test results indicate that it does not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- D. Do not cover air/vapor barrier membrane until field quality control testing has been completed.

3.7 CLEANING, PROTECTING, AND REPAIR

- A. Cleaning: Immediately after completing spraying operations, remove material overspray and fallout from surfaces of other construction not to be coated and clean exposed surfaces to remove evidence of soiling.
 - 1. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
- B. Repair damage to air/vapor barrier membrane caused by construction activities or subsequent work prior to covering membrane.
- C. Coordinate installation of exterior rigid insulation with application of air/vapor barrier membrane. Adhere insulation to air/vapor barrier membrane after initial set time of 1 to 2 hours, and while membrane is still tacky, to prevent convection currents occurring behind insulation.
- D. Schedule work to ensure that the air/vapor barrier system is covered as soon as possible after application and inspection. Protect air/vapor barrier system from damage during subsequent operations. If the air/vapor barrier system cannot be covered within 30 days after installation, apply temporary UV protection such as dark plastic sheet or tarpaulins.

END OF SECTION 072726

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SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1.
2. Mechanically fastened ethylene-propylene-diene-monomer (EPDM) roofing system.
3. Roof insulation.
4. Roof accessories, including expansion joints, and walkways.

B. Related Requirements:

1. Division 06 Section "Rough Carpentry" for material description and installation requirements for wood nailers and blocking.
2. Division 07 Section "Thermal Insulation" for insulation at vertical face of parapet.
3. Division 07 Section "Fluid-Applied Air/Vapor Barrier System" for tie-in with roof system.
4. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Division 07 Section "Roof Accessories" for fall arrest anchors (roof tie-offs) penetrating roof membrane.
6. Division 22 Sections for roof drains.

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.
- B. Thermal Resistivity: Where the thermal resistivity of insulation products are designated by "r-values," they represent the reciprocal of thermal conductivity (k-values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1-inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site. Review methods and procedures related to roofing system including, but not limited to, the following:
 1. Meet with Architect, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories, skylights and roof-mounted equipment.

2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
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. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review construction schedule to minimize construction activities on completed roofing.
8. Review temporary protection requirements for roofing system during and after installation.
 - a. Review staging, material placement, construction activity and pedestrian traffic protection requirements for work areas and access paths to areas where work will occur on completed roofing.
9. Review roof observation and repair procedures after roofing installation. Establish monitoring procedures for construction activities and recording of damage by sub-trades.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
11. Provide 7 business days minimum advance notice to participants prior to convening preinstallation conference.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work. Customized detail sheets shall be prepared showing each condition and approved installation method conforming with construction drawing constraints and details.
 1. Base flashings and membrane terminations.
 2. Tapered insulation, including slopes.
 3. Roof plan showing orientation of steel roof deck and orientation of roofing and fastening spacings and patterns for mechanically fastened roofing.
 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
 5. Roof flashing details shall be consistent with those shown on Drawings. Where cap flashing is shown, a standard manufacturer's bar anchor only detail is not acceptable. Membrane manufacturer's recommended flashing detail may be considered by the Architect when no detail is provided.

1.6 INFORMATIONAL SUBMITTALS

- A. Installer Qualification Data: For qualified Installer signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
- B. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified, independent testing agency, for components of roofing system.
 1. Insulation Test Reports: Include insulation test reports evidencing compliance with specified requirements including those for thermal resistance, fire test response

characteristics, water-vapor transmission, water absorption, and other properties, based on comprehensive testing of current products.

- C. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- D. Test data for pullout resistance of fastening system.
- E. Pull Test: Submit results of insulation adhesive pull test.
- F. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.
- G. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.
- B. Warranties: Special warranties specified in this Section.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is factory trained and licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty. Contractor shall have a minimum of 5 years experience installing the system, have installed a minimum of 500,000 square feet and shall employ personnel experienced and skilled in the application of the manufacturer's roofing system.
 - 1. Work associated with membrane roofing including, but not limited to, insulation, flashing, and membrane sheet joint sealers, shall be performed by Installer of this Work.
- B. Roofing work shall be applied in strict accordance with the provisions of the specification criteria. No deviations shall be permitted without written consent from the Architect. Should a conflict between this specification and the manufacturer's requirements arise, the most restrictive provision as determined by the Architect shall govern.
- C. Upon completion of the installation, an inspection shall be made by the roofing system manufacturer to ascertain that the roofing system has been installed according to applicable manufacturer's specifications and details. No "early bird" warranty will be accepted. Results of the warranty inspection shall be submitted in writing to Owner and Architect for their review and records.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life of liquid materials, approval or listing agency markings, and manufacturer's written instructions for storing and mixing with other components. Comply with manufacturer's written instructions for proper material storage.

- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
 - 1. Insulation and cover board shall be stored on pallets, not less than 4 inches off ground, tightly covered with waterproof, "breathable" materials. Protect insulation from direct sunlight.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.
 - 1. Do not overload any portion of building either by use of or placement of equipment, storage of debris, or storage of materials. Construction loads shall not exceed 25 pounds per square foot.
- E. Materials shall be delivered in sufficient quantity to allow continuity of Work.
- F. Materials, which are damaged, shall be removed and replaced at Installer's expense.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
 - 1. Weather protection shall mean the temporary protection of that work adversely affected by moisture, wind, heat, and cold by covering, patching and sealing, enclosing, ventilation, cooling and/or heat.
- B. Proceed with work so roofing materials are not subject to construction traffic. When construction traffic is necessary, roof sections shall be protected with plywood or other appropriate material to prevent damage; remove protection after construction traffic has ceased and re-inspected for possible damage.
- C. Substrate Conditions: Do not begin roofing installation until substrates have been inspected and are determined to be in satisfactory condition. All surfaces shall be smooth, dry, clean, free of fins or sharp edges, loose or foreign materials, oil or grease. No work shall proceed when moisture is present on roof or in substrate materials.
- D. Temporary Water Stops: Install at end of each workday and remove before proceeding with next day's work.
- E. Protect against fire and flame spread. Maintain proper and adequate fire extinguishers.
- F. Take precautions to prevent drains from clogging during roofing application. Remove debris at completion of each day's work and clean drains, if required. At completion, test drains to ensure system is free running and drains are watertight. Remove strainers and plug drains in

areas where work is in progress. Install flags or other telltales on plugs. Remove plugs each night and screen drain.

- G. If exterior walls are not erected at time of membrane installation, envelop flutes of metal deck to prevent moisture intrusion and wind damage.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks. The maximum wind speed coverage shall be peak gusts of 72 mph measured at 10 meters above ground level. Warrantor shall be the manufacturer of the roofing membrane. Warranty shall be written to building Owner.
 - 1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, roofing accessories, walkway products, and other components of roofing system.
 - 2. Warranty Period: 20 years from date of Substantial Completion.
- B. When the Warrantor is notified that there is a problem (leak or damage) with warranted roofing system and/or accessories by telephone, and/or in writing (fax, e-mail or mail), the response time to physically start repairs shall be within twenty-four hours from time of telephone or date of written notification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain components including roof insulation, cover board and fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer for a total system warranty.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
 - 1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
 - 2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

- C. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE 7.
 - 1. Corner Uplift Pressure: 60 lbf/sq. ft.
 - 2. Perimeter Uplift Pressure: 40 lbf/sq. ft.
 - 3. Field-of-Roof Uplift Pressure: 24 lbf/sq. ft.
- D. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- E. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.
- F. Insulation Fire Performance Characteristics: Provide insulation and related materials with the fire test response characteristics specified elsewhere in this Section as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface Burning Characteristic: ASTM E 84.
 - 2. Fire Resistance Ratings: ASTM E 119.
 - 3. Combustion Characteristics: ASTM E 136.

2.3 EPDM ROOFING

- A. EPDM: ASTM D 4637, Type I, nonreinforced, uniform, flexible EPDM sheet.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.
 - c. Versico Incorporated.
 - 2. Thickness: 90 mils, nominal.
 - 3. Exposed Face Color: Black.

2.4 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
- B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.
- C. Bonding Adhesive: Manufacturer's standard capable of withstanding Project wind uplift requirements.
- D. Seaming Material: Manufacturer's standard splice tape for sealing lapped joints, including edge sealer to cover exposed spliced edges as recommended by membrane manufacturer.
- E. Lap Sealant: Manufacturer's standard, single-component sealant.

- F. Membrane Adhesive: As recommended by membrane manufacturer for particular substrate and project conditions, formulated to withstand specified uplift force.
- G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- H. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- I. Crickets and Flashing Accessories: Types recommended by membrane manufacturer, including adhesive tapes, flashing cements, and sealants.
 - 1. Crickets: Tapered factory pre-cut crickets, extending to roof drain sumps, 1/2-inch taper.
- J. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
 - 1. Fasteners into Preservative Treated Lumber: Stainless steel only.
- K. Miscellaneous Accessories: Provide preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
 - 1. Pourable sealers not allowed.
 - 2. Field-formed pipe flashing not allowed.
- L. Expansion Joint Bulb: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible, closed-cell polyethylene foam, nonabsorbent to liquid water and gas; size as needed to meet expansion joint conditions.
- M. Insulation Retainer and Insulation for Expansion Joints:
 - 1. Insulation Retainer: Continuous EPDM sheet, minimum 45-mil thickness, with sealed seams.
 - 2. Insulation: Unfaced, glass-fiber blanket (batt) insulation, ASTM C 665, Type I; consisting of fibers manufactured from inorganic glass bonded with thermosetting resin; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics
 - a. R-Value: Not less than R-21.
- N. Roof Walkways: Shall be premolded 30 inch wide rubber walkways supplied by membrane manufacturer.

2.5 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by EPDM roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289-11, Type II, Class 1, Grade 2, 20 psi, glass-fiber mat facer on both major surfaces.
 - 1. Insulation LTTR-Values: Not less than R-5.8 per inch.
 - 2. Thickness:
 - a. At Pitched Steel Construction: 2 layers of 3 inch thick insulation for a total thickness of 6 inches.

- b. At Flat Steel Construction: 1 layer of 3 inch thick insulation covered with tapered insulation.
 - 3. Products:
 - a. Carlisle SynTec Inc.; Polyiso HP-H.
 - b. Dow Chemical Co.; Hy-Therm AP.
 - c. Firestone Building Products Co.; ISO 95+.
 - d. Johns Manville International, Inc.; E'nerg'y 3.
 - 4. Provide roofing manufacturer's required insulation for total system warranty.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.
- 1. Tapered insulation shall meet requirements specified for board roof insulation. Provide tapered boards where indicated.
 - 2. Tapered insulation at roof drains shall slope 1/2 inch per 12 inches, unless otherwise indicated.
 - 3. Tapered insulation shall be manufactured by same manufacturer of board roof insulation.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive for Acoustical Roof Deck at Gym Roof and for Cover Board installation: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Full-spread spray-applied, low-rise, two-component urethane adhesive.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
 - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 - 2. Verify that wood blocking and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with manufacturer's instructions to prepare substrate to receive EPDM membrane roof system.
- B. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- C. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- D. Install insulation strips according to acoustical roof deck manufacturer's written instructions.

3.3 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking," according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry. Protect acoustical roof deck rib insulation strips from exposure to water.
- D. Install tapered insulation under area of roofing to conform to slopes indicated, or if not indicated, as required for positive drainage to roof drains.
- E. Install insulation under area of roofing to achieve required thickness. Install layers, including tapered layers, with joints of each succeeding layer staggered from joints of previous layer a minimum of 12 inches in each direction with no gaps, to form a complete thermal envelope.
- F. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- G. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
 - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

- H. Mechanically Fastened Insulation: Install each layer of flat and tapered insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof, but in no case, provide less than one anchor per 4 sq. ft. of surface area (8 fasteners per 4 x 8 foot board).
 - 2. Screws shall be installed utilizing automatic, positive clutch disengaged and adjustable nosepiece.
 - 3. Install tapered edge strips at edges of tapered insulation to provide smooth transition to flat areas, free of gaps and voids.
 - 4. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
- I. Do not install more insulation in a day than can be covered with membrane before end of day or before start of inclement weather.

3.5 MECHANICALLY FASTENED MEMBRANE ROOFING INSTALLATION

- A. Mechanically fasten roofing over area to receive roofing according to roofing system manufacturer's written instructions and approved Shop Drawings. Unroll membrane roofing and allow to relax before installing.
 - 1. For in-splice attachment, install roofing with long dimension perpendicular to steel roof deck flutes.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Mechanically fasten or adhere roofing securely at terminations, penetrations, and perimeter of roofing.
- E. Apply roofing with side laps shingled with slope of roof deck where possible.
- F. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.
 - 1. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.
- G. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.
- H. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.
- I. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

- J. In-Splice Attachment: Secure one edge of roofing using fastening plates or metal battens centered within splice, and mechanically fasten roofing to roof deck. Field splice seam.
- K. Through-Membrane Attachment: Secure roofing using fastening plates or metal battens, and mechanically fasten roofing to roof deck. Cover battens and fasteners with a continuous cover strip.
- L. Adhere protection sheet over membrane roofing at locations indicated.

3.6 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions and approved Shop Drawings.
- B. Flashing of parapets, curbs, expansion joints, and other parts of the roof shall be performed using EPDM membrane flashing.
- C. At roof edges, membrane shall run under metal roof edge flashing full length and width. Membrane shall extend down wall at least 1-inch past bottom of wood nailer, lapping over wall finish, but not exposed below flashing.
- D. Flash all projections including pipes, conduits, fall arrest anchors, and curbs passing through membrane.
 - 1. Flash pipes and conduits with pre-molded cone type flashing boots. Do not field fabricate pipe flashing.
- E. Base Flashing: Tops of elastomeric base flashing shall be secured with a continuous aluminum termination bar, sealed and counterflashed.
- F. All vertical flashings and membranes shall be adhered to substrates regardless of height.
- G. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
 - 1. Keep exposed surface of EPDM free of adhesive.
- H. Flash penetrations and field-formed inside and outside corners with sheet flashing conforming to manufacturer's requirements. Provide a minimum overlap of 3-inches.
- I. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
 - 1. Keep exposed surface of EPDM free of adhesive.
- J. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.7 WALKWAY INSTALLATION

- A. Flexible Roof Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions. Install roof walkways at all traffic concentration points (such as roof

hatches, access doors, rooftop ladders, around mechanical equipment, etc.); all locations as identified on the Drawings; and all locations required by manufacturer for obtaining warranty.

3.8 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
 - 1. Notify Architect not less than 5 business days in advance of date and time of inspection.
- B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.9 PROTECTING AND CLEANING

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

END OF SECTION 075323

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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following sheet metal flashing and trim:
 - 1. Manufactured roof copings.
 - 2. Formed low-slope roof flashing and trim.
 - 3. Formed counterflashing and base flashing.
 - 4. Formed roof drainage system.
 - 5. Formed wall flashing and trim.
 - 6. Miscellaneous sheet metal accessories.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Division 07 Section "Composite Wall Panels" for factory-formed composite wall panels and flashing and trim not part of sheet metal flashing and trim.
 - 3. Division 07 Section "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing" for installing sheet metal flashing and trim integral with roofing membrane.
 - 4. Division 07 Section "Roof Accessories" for roof hatches and other manufactured roof accessory units.
 - 5. Division 07 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.
- C. Products furnished, but not installed, under this Section include the following:
 - 1. Counterflashing receivers in masonry joints for metal flashing and base flashing, installed under Division 04 Section "Unit Masonry Assemblies."
 - 2. Counterflashing receivers and through parapet scuppers in composite panels, installed under Division 07 Section "Composite Wall Panels."

1.3 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. SPRI Wind Design Standard for Manufactured Roof Edge Flashings: Manufacture and install roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
 - 1. Design Wind Uplift: As follows:
 - a. Corner Uplift Pressure: 50 PSF.
 - b. Perimeter Uplift Pressure: 36 PSF.

- C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and installation instructions.
- C. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Provide layouts at 1/4-inch scale and details at 3-inch scale. Include the following:
 - 1. Identify material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 - 3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
 - 4. Include details of termination points and assemblies.
 - 5. Include details of roof-penetration flashing.
 - 6. Details of edge conditions, including roof edges and counterflashings as applicable.
 - 7. Details of connections to adjoining work.
- D. Samples for Initial Selection: For each type of sheet metal flashing and trim indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
- E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Manufactured Roof Coping: 12 inches long. Include fasteners and other exposed accessories. Provide with selected finish.
 - 2. Sheet Metal Flashing: 12 inches long. Include fasteners, cleats, clips, closures, and other attachments.
 - 3. Accessories: Full-size Sample.
- F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material, design, forming method, and extent to that indicated for this Project and with a record of successful in-service performance for ten years.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual, Fifth Edition." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
 - 1. Copper Standard: Comply with CDA's "Copper in Architecture Handbook."
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Meet with Owner, Architect, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to sheet metal flashing and trim.
 - 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 - 4. Review mockup.
 - 5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
 - 6. Provide not less than 5 business days advance notice to participants prior to convening preinstallation conference.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
- B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, staining, and surface damage.
- C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 - 1. Store tin-zinc alloy coated copper away from uncured concrete and masonry.

1.7 COORDINATION

- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.
- B. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation to ensure a weathertight installation.

1.8 WARRANTY

- A. General: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to,

and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Installer's Warranty: Installer's warranty, on warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of custom-fabricated sheet metal flashing and trim that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Loose parts.
 - c. Wrinkling or buckling.
 - d. Failure to remain weathertight, including uncontrolled water leakage.
 - 2. Warranty Period: Two years for date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 SHEET METALS

- A. Tin-Zinc Alloy Coated Copper: ASTM B 370, Temper H00, cold-rolled copper sheet, of minimum 16 oz. uncoated weight (thickness), coated both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin), total weight (thickness) of 17.2 oz/sq. ft..
 - 1. Product: FreedomGray, Revere Copper Products, Inc.
- B. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.
 - 2. Exposed Finishes: Apply the following coil coating:
 - a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and

fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:

- a) Humidity Resistance: 2000 hours.
 - b) Salt-Spray Resistance: 2000 hours.
- 2) Color: As selected by Architect from manufacturer's full range.
- C. Prefinished Aluminum Sheet: ASTM B 209, Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:
1. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
 2. Obtain coil stock from composite wall panel manufacturer to assure color match.

2.3 UNDERLAYMENT MATERIALS

- A. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
- B. Slip Sheet: Rosin-sized paper, minimum 5-lb/100 sq. ft..
- C. Self-Adhering Sheet Underlayment, High Temperature: Minimum of 30- to 40-mil- thick, slip-resisting, polyethylene-film-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release paper backing; cold applied.
1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
 3. Products:
 - a. Dri-Start "HR"; Carlisle Coatings & Waterproofing, Div. of Carlisle Co., Inc.
 - b. Vycor Ultra; Grace, W. R. & Co.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
1. Nails for Tin-Zinc Alloy Coated Copper Sheet: Copper or hardware bronze, 0.109 inch minimum and not less than 7/8 inch long, barbed with large head.
 2. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating.
 3. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.

4. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
 5. Fasteners into Preservative Treated Lumber: Stainless steel.
- C. Solder for Zinc-Tin Alloy-Coated Copper: ASTM B 32, 100 percent tin.
 - D. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
 - E. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
 - F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
 - G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
 - H. Elastic Flashing Filler: Closed cell polyethylene or other soft closed cell material recommended by elastic flashing manufacturer as fill under flashing loops to ensure movement with minimum stress on flashing sheet.

2.5 MANUFACTURED ROOF COPINGS

- A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet, concealed splice plates and concealed, continuous galvanized-steel sheet cleats. Provide matching factory mitered, welded corner units, end cap units, and concealed splice plates with finish matching coping caps. Coping assembly shall be SPRI ES-1 compliant.
 1. Products:
 - a. W. P. Hickman Company; Permasnap 2 Coping System.
 - b. Metal-Era, Inc.; Tapered Perma-Tite Coping System.
 - c. Johns Manville, Inc.; Presto Lock Coping System.

2.6 CUSTOM FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual, Fifth Edition" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
- B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
- C. Fabricate sheet metal flashing and trim in minimum 96-inch- lengths, but not exceeding 10-foot- long sections.
- D. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 1. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- E. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
 - F. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used or would not be sufficiently water/weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.
 - G. Separations: Provide for separation of metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact, with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or other permanent separation as recommended by manufacturer/fabricator.
 - H. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
 - I. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
 1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

2.7 CUSTOM FABRICATED FLASHING SCHEDULE

- A. Through Parapet Scupper: SMACNA, similar to Figure 1-28 with flat spillout scupper edge as detailed with continuous 20 gage galvanized steel edge cleat; turn sides up to flash under composite panel coping; prefinished aluminum sheet not less than 0.040 inch thick.
- B. Two-Piece Counter Flashing for Membrane Flashing at Masonry: SMACNA, Figure 4.3C (modified); turn vertical leg up 8 inches; make horizontal leg run back to wall sheathing; 12-inch wide L-shaped back-up plates for receiver joints, 16 oz. tin-zinc alloy coated copper receiver; 20 oz. tin-zinc alloy coated copper insert flashing. Furnish receiver flashing and back-up plates to mason for installation into brickwork.
- C. Two-Piece Counter Flashing for Membrane Flashing at Composite Wall Panels: SMACNA, Figure 4.3C (modified); turn vertical leg up 8 inches; 12-inch wide L-shaped back-up plates for receiver joints. Fabricated from prefinished, aluminum- sheet matching composite wall panels; minimum 0.040 inch thickness for receiver and insert flashing. Furnish receiver flashing and back-up plates to composite panel installer for installation into siding work.
- D. Louver Sill Flashing at Masonry: Shop formed to detail, continuous clips; not less than 16 oz. tin-zinc alloy copper.
- E. Miscellaneous Flashing at Masonry: Formed to detail; not less than 16 oz. tin-zinc alloy coated copper.

2.8 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted 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 substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
 - 1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
 - 2. Bed flanges in thick coat of water cutoff mastic where required for waterproof performance.
- C. Install sheet metal flashing and trim with minimum number of joints practical, using manufactured or shop fabricated full-length pieces. Provide one piece flashing and trim using full-length pieces without joints where run is less than the 8 to 10 foot fabricated lengths. Do not use pieces less than 24 inches long.
 - 1. Sill Flashing at Openings: Provide one piece flashing, full width of opening except where opening exceeds available manufactured/fabricated lengths. Provide sealed metal

end dams at ends of sills. Sills flashing shall turn up on back side to form pan, directing water to the exterior.

- D. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- E. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
- F. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 1. Cleats shall be continuous, unless otherwise noted.
- G. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.
- H. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
 - 1. Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.
 - 2. Tin-Zinc Alloy Coated Copper: Use copper or stainless steel fasteners.
 - 3. Prefinished Aluminum Sheet: Use aluminum or stainless-steel fasteners.
- I. Seal joints with elastomeric sealant as required for watertight construction.
 - 1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 - 2. Prepare joints and apply sealants to comply with installation requirements in Division 07 Section "Joint Sealants."
- J. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Prein edges of sheets to be soldered to a width of 1-1/2 inches except where pretinned surface would show in finished Work.
 - 1. Do not solder prepainted, metallic-coated steel sheet.
 - 2. Pretinning is not required for zinc-tin alloy-coated copper.
 - 3. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.3 INSTALLATION OF MANUFACTURED ROOF COPING

- A. General: Install manufactured roof specialties according to manufacturer's written instructions. Anchor with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements. Use fasteners, separators, sealants, and other miscellaneous items as required to complete manufactured roof specialty systems.
 - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 - 4. Install manufactured roof specialties with provisions for thermal and structural movement.
 - 5. Torch cutting of manufactured roof specialties is not permitted.
 - 6. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
- C. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- D. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
 - 1. Interlock face and back leg drip edges of snap-on coping cap into continuous cleats anchored to substrate at not more than 30 inch centers.

3.4 CUSTOM FABRICATED FLASHING AND TRIM INSTALLATION

- A. General: Except as otherwise indicated, install sheet metal flashing and trim comply with fabricator's installation instructions, performance requirements, and SMACNA "Architectural Sheet Metal Manual, Fifth Edition." 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. All edge strips shall be neatly folded; external and internal corners shall be mitered and soldered for copper, and sealed in full bed of water cut off mastic for pre-finished metal. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.
 - 1. Fabricate in minimum 96-inch- long sections, but not exceeding 10-foot-long sections.
- B. Back-Up Plates: Where specified, set flashing ends in full bed of water cut-off mastic, allowing 1/4-inch between sections.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant.
 - 1. Install receivers to receive counterflashing in manner and by methods indicated. Where shown in masonry, provide reglets to mason for installation as specified in Division 04 Section "Unit Masonry Assemblies."

2. Secure in a waterproof manner by means of snap-in installation or welding in-place. Fill reglets with mastic or elastomeric sealant, as indicated and depending on degree of sealant exposure.
 3. Verify correct installation of receiver flashing with back-up plates properly set and sealed at joints for two-piece counter flashing detail.
- D. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face and under roofing membrane.
1. Anchor scupper closure trim flange to exterior wall and seal to scupper.
- E. Install flashing and sheet metal with concealed fasteners, unless indicated otherwise. Metal edge flashing shall be installed to resist wind blow-off and prevent flutter and vibration. Allow for expansion and contraction, making square, straight corners and tight overlaps, free of gaps and openings, properly sealed to be watertight.
- F. Electrolytic Action: Where two dissimilar metals adjoin or lap each other (example: galvanized metal ducts and copper cap flashing), an approved separating strip or other insulating material shall be installed.
- G. Bed flanges of work in water cut off mastic where required for waterproof performance.

3.5 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- E. Remove temporary protective coverings and strippable films as roof copings are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, and pieces of flashing. Maintain roof copings in a clean condition during construction.
- F. Replace roof copings that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

3.6 INSTALLER'S WARRANTY

- A. WHEREAS **<Insert name>** of **<Insert address>**, herein called the "Installer," has performed siding, roofing, flashing and associated work ("work") on the following project:
 1. Owner: **<Insert name of Owner.>**
 2. Address: **<Insert address.>**

3. Building Name/Type: <Insert information.>
4. Address: <Insert address.>
5. Area of Work: <Insert information.>
6. Acceptance Date: <Insert date.>
7. Warranty Period: <Insert time.>
8. Expiration Date: <Insert date.>

- B. AND WHEREAS Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding 70 mph.
 - c. fire;
 - d. failure of siding and roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of work; and
 - g. activity on work by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
 2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 3. Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 4. During Warranty Period, if Owner allows alteration of work by anyone other than Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Installer to perform said alterations, Warranty shall not become null and void unless Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

6. Owner shall promptly notify Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of siding, roofing, flashing, or trim failure. Specifically, this Warranty shall not operate to relieve Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <Insert day> day of <Insert month>, <Insert year>.

1. Authorized Signature: <Insert signature.>
2. Name: <Insert name.>
3. Title: <Insert title.>

END OF SECTION 076200

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SECTION 077200 - ROOF ACCESSORIES

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. Roof hatches.
 - 2. Ladder extension device.
 - 3. Fall arrest anchors.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for metal vertical ladders for access to roof hatches.
 - 2. Division 06 Section "Rough Carpentry" for wood nailers.
 - 3. Division 07 low-slope roofing Sections for roof expansion-joints and roofing accessories.
 - 4. Division 07 Section "Sheet Metal Flashing and Trim" for shop- and field-fabricated metal flashing and counterflashing, and miscellaneous sheet metal trim and accessories.
 - 5. Division 23 Sections for roof curbs and equipment supports.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of roof accessory indicated. Include manufacturer's detailed technical product data; installation instructions and recommendations; and construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: Show fabrication and installation details for roof accessories. Show layouts of roof accessories including plans and elevations. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other work.
- D. Delegated-Design Submittal for Fall-Protection System: Designed and engineered by manufacturer employed OSHA certified engineer. System shall comply with OSHA standards 29 CFR 1910.66 App C, Section 1, (c) (9), proposed 29 CFR 1910.128 (c) (9) and 29 CFR 1926(d) (8).
 - 1. Include complete roof layout and configuration of the fall protection systems, including all components and accessories.
 - 2. Show dimensioned layout, member profiles, sizes, anchorage system, connection details to structure, and other accessories for the complete fall protection system.
 - 3. Loads imposed on the system terminations and intermediate supports are calculated for each installation assuming the worst-case scenario to insure the anchorage strength meets or exceeds double the calculated loads as required by OSHA.

4. Include structural analysis data for the components signed and sealed by the qualified professional engineer responsible for their preparation.

E. Qualification Data: For Installer of Fall-Protection System.

1.4 QUALITY ASSURANCE

- A. Sheet Metal Standard: Comply with the following:
 1. SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.
 2. NRCA's "Roofing and Waterproofing Manual" details for installing units.
- B. Installer of Fall-Protection System Qualifications: Shall be approved in writing by the fall-protection system manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 METAL MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 coated and mill phosphatized for field painting.

- B. Aluminum Sheet: ASTM B 209, alloy and temper recommended by manufacturer for type of use and mill finish.
- C. Aluminum Extrusions and Tubes: ASTM B 221, alloy and temper recommended by manufacturer for type of use, mill finished.
- D. Stainless-Steel Shapes or Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 or Type 316, No. 2D finish.
- E. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized to comply with ASTM A 123/A 123M, unless otherwise indicated.
- F. Steel Tube: ASTM A 500, round tube, baked-enamel finished.
- G. Galvanized Steel Tube: ASTM A 500, round tube, hot-dip galvanized to comply with ASTM A 123/A 123M.
- H. Galvanized Steel Pipe: ASTM A 53/A 53M.

2.3 MISCELLANEOUS MATERIALS

- A. Polyisocyanurate Board Insulation: ASTM C 1289, 1 inch thick, unless indicated otherwise.
- B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- C. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.
- D. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.
- E. Elastomeric Sealant: ASTM C 920, polyurethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.4 ROOF HATCHES

- A. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and insulated double-wall curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.
 1. Products: Provide one of the following products with the specified ugrades:
 - a. Bilco Company (The); Type F-50.
 - b. Nystrom, Inc.; Type RHPA.
 2. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loads.
 3. Type and Size: Single-leaf lid, 48 by 48 inches.
 4. Curb and Lid Material: Aluminum sheet, 0.090 inch thick.

- a. Finish: Mill.
- 5. Insulation: Polyisocyanurateboard, 2 inches thick, for both lid and curb. Insulation shall be fully covered and protected by an interior liner panel.
- 6. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
- 7. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
- 8. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
- 9. Hardware: Galvanized steel spring latch with turn handles, both inside and exterior, butt-or pintle-type hinge system, and padlock hasps inside and outside.
- 10. Ladder Safety Post: Manufacturer's standard ladder safety post for attachment to roof-access ladder. Post to lock in place on full extension. Provide release mechanism to return post to closed position.
 - a. Height: 42 inches above finished roof deck.
 - b. Material and Finish: Steel tube, baked enameled.
 - c. Diameter: Pipe with 1-5/8-inch OD tube.
- 11. Safety Railing System: Manufacturer's standard complete system including rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation. System shall comply with OSHA 29 CFR 1910.23 and OSHA strength requirements with a safety factor of two.
 - a. Height: 42 inches above finished roof deck.
 - b. Pipe or Tube: Manufacturer's standard; pultruded, fire-retardant, fiberglass-reinforced polymer in safety yellow and treated with a UV inhibitor; 1-1/4-inch ID galvanized pipe; or 1-5/8-inch OD galvanized tube.
 - c. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
 - d. Pipe Ends and Tops: Covered or plugged with weather-resistant material.
 - e. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members that are exposed to exterior or to moisture from condensation or other sources.
 - f. Fabricate joints that will be exposed to weather in a watertight manner.
 - g. Close exposed ends of handrail and railing members with prefabricated end fittings.
 - h. Fasteners: Manufacturer's standard.

2.5 FALL ARREST ANCHORS (ROOF TIE-OFFS)

- A. Fall Arrest Anchors (Roof Tie-Offs): Roof safety U-Bar, not less than 3/4-inch diameter material with 1-1/2 inch eye opening. U-bar shall be attached to a galvanized steel post with base plate for anchoring to steel beams, bar joists or metal decking based on location of tie-off.
 - 1. Quantity: As required for compliance with OSHA 1926.502.
 - 2. Product: CB Series Roof Anchors; Guardian Fall Protection; phone: (800) 466-6385; website: <http://www.guardianfall.com>.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
2. Verify dimensions of roof openings for roof accessories.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions and recommendations. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Install roof accessories to fit substrates and to result in watertight performance. Install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual," unless otherwise indicated.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
- D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
- E. Roof Hatch Installation:
 1. Check roof hatch for proper operation. Adjust operating mechanism as required. Clean and lubricate joints and hardware.
 2. Attach safety railing system to roof hatch curb.
 3. Attach ladder safety post according to manufacturer's written instructions.
- F. Installation of Fall Arrest Anchors: Install in accordance with manufacturer's instructions and approved Shop Drawings.
- G. Seal joints with elastomeric sealant as required by manufacturer of roof accessories.

3.3 CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.

END OF SECTION 077200

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SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.
4. Compliance with requirements of UL assemblies indicated for fire-rated construction.

B. Related Sections:

1. Division 07 Section "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.
2. Division 07 Section "Joint Sealants" for non-fire-resistive joint sealants.
3. Division 09 Section "Gypsum Board Assemblies" for firestopping where fire rated gypsum board assemblies butt adjacent construction including masonry, steel deck, joists, beams, floors, roofs and structural members.
4. Division 21, 22 and 23 Sections specifying duct and piping penetrations, including fire-suppression piping.
5. Division 26 and 27 Sections specifying cable and conduit penetrations.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated. Include installation instructions.
- C. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
 1. Submit documentation, including illustrations applicable to each through-penetration firestop system configuration for construction and penetrating items.
- D. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

- E. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified, independent testing agency, for penetration firestopping.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated or required for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
- C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
 - b. Classification markings on penetration firestopping correspond to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."
- D. Provide through-penetration firestop system products containing no detectable asbestos as determined by the method specified in 40 CFR Part 763, subpart F, Appendix A, Section 1, "Polarized Light Microscopy."
- E. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate Work of this Section with the work of other trades to assure the proper sequencing of each installation and to provide a fire- and smoke-resistant installation.
- B. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- C. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.
- D. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.
- E. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A/D Fire Protection Systems Inc.
 - 2. Grace Construction Products.
 - 3. Hilti, Inc.
 - 4. Johns Manville.
 - 5. Nelson Firestop Products.
 - 6. NUCO Inc.
 - 7. Passive Fire Protection Partners.
 - 8. RectorSeal Corporation.
 - 9. Specified Technologies Inc.
 - 10. 3M Fire Protection Products.
 - 11. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - 12. USG Corporation.

2.2 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements required, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
 - 1. Provide paintable through-penetration firestop products at locations exposed to view, except at mechanical, electrical and elevator machine rooms.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Horizontal assemblies include floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
 - 2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 - 3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.
- E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Collars.
 - 5. Steel sleeves.

2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- C. Install fill materials for firestopping by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency, UL system number and date.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Owner may engage a qualified testing agency to perform tests and inspections.
- B. Allow for 3 random samples of each type of firestopping system to be inspected. Reinstall disturbed samples to comply with requirements.
- C. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
 - 1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- D. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

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SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

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 fire-resistive joint systems for the following:
 1. Floor-to-floor joints.
 2. Floor-to-wall joints.
 3. Head-of-wall joints.
 4. Wall-to-wall joints.
 5. Wall-to-adjacent structure and supports.
 6. Compliance with requirements of UL assemblies indicated for fire-rated construction.
- B. Related Sections include the following:
 1. Division 07 Section "Penetration Firestopping" for systems installed in openings in walls and floors with and without penetrating items.
 2. Division 07 Section "Joint Sealants" for non-fire-resistive joint sealants.
 3. Division 09 Section "Gypsum Board Assemblies" for firestopping where fire rated gypsum board assemblies butting adjacent construction including masonry, steel deck, joists, beams, floors, roofs and structural members.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joint Systems in and between Fire-Resistance-Rated Constructions: Provide systems with assembly ratings equaling or exceeding the fire-resistance ratings of construction that they join, and with movement capabilities and L-ratings indicated as determined by UL 2079.
 1. Load-bearing capabilities as determined by evaluation during the time of test.
 2. For fire-resistance systems with movement capabilities, allow for the following movement.
 - a. Floors: 3/4-inch deflection.
 - b. Roofs: 1 1/2-inch deflection.
 3. Provide systems with L-rating where walls and partitions also are smoke barriers. Where a fire-resistive joint system is not available with the ability to resist smoke, provide smoke sealant material to one side of wall to stop the passage of smoke.
- C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.
 1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.

- D. For fire-resistive systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
 - 1. For fire-resistive joint systems exposed to view in public spaces upon completion of Work, provide products that are paintable.
 - a. Mechanical, electrical and elevator machine rooms are not considered public spaces.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated. Include installation instructions.
- C. Shop Drawings: For each fire-resistive joint system, show each kind of construction condition in which joints are installed; also show relationships to adjoining construction. Include fire-resistive joint system design designation of testing and inspecting agency acceptable to authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.
 - 2. For those fire-resistive joint system applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from a similar UL system design or other tests shall be submitted to local authorities having jurisdiction for their review and approval prior to installation. Manufacturer's engineering judgment shall follow requirements set forth by the International Firestop Council.
- D. Product Certificates: For each fire-resistive joint system. Include location and design designation of qualified testing agency.
 - 1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- E. Qualification Data: For Installer.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.
- G. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that required for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

- B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
- C. Source Limitations: Obtain fire-resistive joint systems, for each kind of joint and construction condition indicated, through one source from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 - 1. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, OPL or another agency performing testing and follow-up inspection services for fire-resistive joint systems acceptable to authorities having jurisdiction.
 - 2. Fire-resistive joint systems are identical to those tested per methods indicated in Part 1 "Performance Requirements" Article and comply with the following:
 - a. Fire-resistive joint system products bear classification marking of qualified testing and inspecting agency.
 - b. Fire-resistive joint systems correspond to those indicated by referencing system designations of the qualified testing and inspecting agency.
- E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.
- C. Remove and replace materials, at no cost to Owner, that cannot be applied within their stated shelf life.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

- C. Do not cover up fire-resistive joint system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector or authorities having jurisdiction have examined each installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide products by one of the following:
 1. A/D Fire Protection Systems Inc.
 2. W.R. Grace & Co., Construction Products Division.
 3. Hilti Construction Chemicals, Inc.
 4. Johns Manville International, Inc.
 5. Nelson Firestop Products
 6. NUCO Inc.
 7. RectorSeal Corporation (The)
 8. Specified Technologies Inc.
 9. 3M Fire Protection Products
 10. Tremco Sealant/Weatherproofing Division
 11. United States Gypsum Company.

2.2 FIRE-RESISTIVE JOINT SYSTEMS

- A. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.
- B. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears of fire-resistive joint system materials from adjoining surfaces. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates or damaging adjoining surfaces.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with Part 1 "Performance Requirements" Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.
- B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.
 2. Apply fill materials so they contact and adhere to substrates formed by joints.
 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner may engage a qualified independent inspecting agency to inspect fire-resistive joint systems and prepare inspection reports.
- B. Before installation of ceilings, walls, and adjacent construction that would conceal fire-resistive joint systems, inspect joints to verify complete installation of fire-resistive joint systems materials.
- C. Remove and replace fire-resistive joint systems where inspections indicate that they do not comply with specified requirements.
- D. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- E. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and fire-resistive joint systems comply with requirements.

3.6 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and substrate manufacturers that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
 - 1. Exterior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Construction and control joints in cast-in-place concrete.
 - b. Joints between plant-precast architectural concrete units and between plant-precast architectural concrete units and adjacent materials.
 - c. Control joints in unit masonry.
 - d. Joints in stone masonry.
 - e. Joints between different materials listed above.
 - f. Perimeter joints between materials listed above and frames of doors, and louvers.
 - g. Other joints as indicated.
 - 2. Exterior joints in the following horizontal traffic surfaces:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated.
 - 3. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
 - d. Perimeter joints between interior wall surfaces and frames of interior doors, and elevator entrances.
 - e. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - f. Other joints as indicated.
 - 4. Interior joints in the following horizontal traffic surfaces:
 - a. Isolation and control joints in exposed cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated.
- B. Related Sections include the following:
 - 1. Division 04 Section "Unit Masonry Assemblies" for masonry control joint fillers and gaskets.
 - 2. Division 07 Section "Sheet Metal Flashing and Trim" for sealing joints related to flashing.
 - 3. Division 07 Section "Through-Penetration Firestop Systems" for sealing penetrations in fire-resistance-rated construction.
 - 4. Division 07 Section "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.
 - 5. Division 08 Section "Glazing" for glazing sealants.

6. Division 08 Section "Glazed Aluminum Curtain Walls" for structural and other glazing sealants.
7. Division 09 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board partitions to reduce sound transmission and for fire-rated sealants in conjunction with fire-rated gypsum assemblies.
8. Division 09 Section "Ceramic Tile" for manufactured control joints in tile flooring.
9. Divisions 21, 22, 23, and 26 for sealing of perimeter joints of plumbing, HVAC systems, automatic fire protection systems, telecommunication systems, and electrical systems.
10. Division 32 Sections for sealing joints in pavements, walkways, and curbing.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide 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 establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each joint-sealant product indicated.
- C. Joint-Sealant Schedule: Include the following information:
 1. Joint-sealant application, joint location, and designation.
 2. Joint design, including width and depth of joint sealant, and backer rod or bond-breaker size and location.
 3. Joint-sealant manufacturer and product name.
 4. Joint-sealant formulation.
 5. Joint-sealant color.
 6. Primer for each substrate type.
 7. Solvent wipe cleaner for each substrate type.
- D. Samples for Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- E. Qualification Data: For Installer.
- F. Field-Adhesion Test Reports: For each sealant test.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in materials, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

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

1.6 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, shelf/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.
- C. Remove and replace materials, at no cost to Owner, that cannot be applied within their stated shelf life.

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 limits permitted by joint-sealant manufacturer or are below 40 deg F.
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
- 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. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation to ensure a weathertight installation.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

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

- B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
 - 1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- E. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 JOINT SEALANTS

- A. Type 1 - General Purpose Exterior Sealant: Polyurethane; ASTM C920, Type S, Grade NS, Class 25; single component.
 - 1. Sonolastic NP-1; Sonneborn, Division of ChemRex Inc.
 - 2. Dymonic; Tremco.
 - 3. Sikaflex-1a; Sika Corporation, Inc.
 - 4. Dynatrol 1; Pecora Corporation.
 - 5. Vulkem 116; Tremco.
 - 6. Chem-Calk 900; Bostik Findley.
- B. Type 2 - General Purpose Exterior Sealant: Single-component, nonsag, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, for Use NT. Shall be no staining on granite, precast concrete and brick per ASTM C 1248.
 - 1. Dow Corning Corporation; 795.
 - 2. GE Advanced Materials - Silicones; SilPruf NB SCS9000.
 - 3. Pecora Corporation; 864NST.
 - 4. Tremco Incorporated; Spectrem 3.
- C. Type 3 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, single component, paintable.
 - 1. Tremflex 834; Tremco.
 - 2. AC-20; Pecora Corporation.
 - 3. Chem-Calk 600; Bostik Findley.
- D. Type 4 - Plumbing Fixture/Tile Sealant: Silicone; ASTM C920, Uses M and A; single component, mildew resistant, color selected by Architect.
 - 1. 898 Silicone; Pecora Corporation.
 - 2. Tremsil 200 Sanitary; Tremco, Inc.
- E. Type 5 - Interior Floor Joint Sealant: Polyurethane, self-leveling; ASTM C920, Grade P, Class 25, Uses T, M and A; single component.
 - 1. Sonolastic SL-1; Sonneborn, Division of ChemRex Inc.
 - 2. Tremflex S/L; Tremco.

3. Sikaflex-1CSL; Sika Corporation, Inc.
 4. NR-201; Pecora Corporation.
 5. Vulkem 45; Tremco.
 6. Chem-Calk 950; Bostik Findley.
- F. Type 6 - Interior Sealant for Food Service Areas: Elastomeric, self-leveling; ASTM C 920; Type S, Grade NS, Class 25, Use NT. Provide elastomeric sealant NSF certified for end-use application indicated. Provide sealant that, when cured and washed, meets requirements of Food and Drug Administration's 21 CFR, Section 177.2600 for use in areas that come in contact with food.
- G. Acoustical Sealant: See Division 09 Section "Gypsum Board Assemblies."

2.3 JOINT-SEALANT BACKING

- A. General: Provide sealant backings (backer rods) of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Plastic Foam Joint Fillers (Backer Rods): ASTM C 1330, Type C, preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
1. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.4 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction 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 joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

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

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), 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 after cleaning operations above 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 recommended in writing by joint-sealant manufacturer, based on prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
 - 1. Masonry, precast concrete, stone and concrete surface shall be primed.
- 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 written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Installation of Sealant Backings (Backer Rods): Install sealant backings to comply with the following requirements:

1. Install sealant backings of type indicated to provide support of sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - a. Do not leave gaps between ends of sealant backings.
 - b. Do not stretch, twist, puncture, or tear sealant backings.
 2. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
 3. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and joint fillers or backs of joints.
- D. Installation of Sealants: Install sealants using 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 and primer are installed.
1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
1. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a. Perform 5 tests for the first 500 feet of joint length for each type of elastomeric sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; do this by extending cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field-adhesion-test log.
 4. Inspect tested joints and report on the following:
 - a. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

- b. Whether sealants filled joint cavities and are free of voids.
 - c. Whether sealant dimensions and configurations comply with specified requirements.
 - 5. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - 6. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

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

3.6 PROTECTION

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

3.7 JOINT-SEALANT SCHEDULE

- A. Control and Soft Joints in Masonry and Between Masonry and Adjacent Work: Type 2; colors as selected. Prime masonry.
- B. Control and Soft Joints in Stone and Between Stone and Adjacent Work: Type 2; colors as selected. Prime stone.
- C. Exterior Joints Between Precast Concrete Units: Type 2; colors as selected. Prime precast concrete.
- D. Joints between Exterior Metal Frames and Adjacent Work (except masonry, stone and precast concrete): Type 2; colors as selected.
- E. Under Exterior Door Thresholds: Type 1.
- F. Exterior Joints for Which No Other Sealant Type is Indicated: Type 2; colors as selected.
- G. Concealed Interior Perimeter Joints of Exterior Openings: Type 1.

- H. Exposed Interior Perimeter Joints of Exterior Openings: Type 3; colors as selected.
- I. Control and Expansion Joints in Interior Concrete Slabs and Floors Left Exposed: Type 5; colors as selected.
- J. Joints between Plumbing Fixtures and Walls and Floors and Between Countertops and Walls: Type 4; colors as selected.
- K. Interior Joints in Food Service Areas: Type 6; colors as selected.
- L. Interior Joints for Which No Other Sealant is Indicated: Type 3; colors as selected.

END OF SECTION 079200

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SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hollow metal doors and frames.
2. Smoke seals and weather stripping gaskets for kerfed frames.

B. Related Sections:

1. Division 07 Section "Building Insulation" for insulation of steel door frames in exterior steel stud walls.
2. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
3. Division 08 Section "Glazing" for glazed lites in steel doors and borrow lites.
4. Division 09 Sections "Painting" for field painting hollow metal doors and frames.
5. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
 1. Submittals for Division 08 Sections "Hollow Metal Doors and Frames," "Wood Doors," "Aluminum-Framed Entrances and Storefronts," "All-Glass Entrances and Storefront," and "Door Hardware" shall be made concurrently.
- B. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.
- C. Shop Drawings: Include the following:
 1. Elevations of each door design.
 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses. Provide dimensions for proper edge clearances of wood and metal doors, including meeting stiles for pairs of doors going into metal frames.
 4. Locations of reinforcement and preparations for hardware.
 5. Details and locations of smoke seals and weather stripping of frames.

6. Details of each different wall opening condition.
 7. Details of anchorages, joints, field splices, and connections.
 8. Details of accessories.
 9. Details of moldings, removable stops, and glazing.
 10. Details of conduit and preparations for power, signal, and control systems.
- D. Door Schedule: Provide a schedule of hollow metal doors and frames prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C (Positive pressure).
1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- C. Door Frame Inspection: Contractor with Installer shall inspect each door frame, checking frame for squareness, alignment, twist, and plumbness before installation of wallboard and masonry to assure proper fit of doors with correct clearances and operation without modification to the door. Frames that are out of tolerance shall be reinstalled to requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Inspect doors and frames on delivery for damage; notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.
- D. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Do not store in a manner that traps excess humidity.
1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ceco Door Products; an Assa Abloy Group company.
 2. Curries Company; an Assa Abloy Group company.
 3. Steelcraft; an Ingersoll-Rand company.
 4. Karpen Steel (Pocket Frame)

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
- G. Grout: Comply with Division 04 Section "Unit Masonry Assemblies."
- H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

- I. Glazing: Comply with requirements in Division 08 Section "Glazing."
- J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 HOLLOW METAL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8, unless more stringent requirements are specified.
 - 1. Design: Flush panel.
 - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core. Provide internal sound deadener on inside of face sheets.
 - a. Fire Door Core: As required to provide fire-protection ratings indicated.
 - b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 11.1 deg F x h x sq. ft./Btu when tested according to ASTM C 518, unless otherwise indicated.
 - 1) Locations: Exterior doors.
 - 3. Vertical Edges for Doors: Beveled edge.
 - a. Beveled Edge: 1/8 inch in 2 inches.
 - 4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick, end closures or channels of same material as face sheets.
 - 5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 3 and Physical Performance Level A (Extra Heavy Duty) (16 Gage), Model 2 (Seamless).
- C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 3 and Physical Performance Level A (Extra Heavy Duty), 16 Gage, Model 2 (Seamless).
- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates of sufficient strength from same material as door face sheets to support hardware without through bolting and to comply with the following minimum sizes:
 - 1. Hinges: Minimum 0.123 inch thick, 10 gage, by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
 - 2. Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick, 8 gage.
 - 3. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick, 8 gage.
- E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.
- B. Exterior Frames: Fabricated from metallic-coated steel sheet.
 - 1. Fabricate frames with mitered or coped corners and seamless face joints.
 - 2. Fabricate frames as full profile welded, unless otherwise indicated.
 - 3. Provide frame with kerf for weatherstripping gaskets.
 - 4. Frames for Level 3 Steel Doors: 0.053-inch- thick, 16 gage, steel sheet.
- C. Interior Frames: Fabricated from cold-rolled steel sheet.
 - 1. Fabricate frames as face welded, unless otherwise indicated.
 - 2. Provide frame with kerf and smoke seals at smoke doors and fire rated doors.
 - 3. Frames for Level 3 Steel Doors: 0.053-inch- thick, 16 gage, steel sheet.
 - 4. Frames for Wood Doors: 0.053-inch- thick, 16 gage, steel sheet.
 - 5. Frames for Borrowed Lights: 0.053-inch- thick, 16 gage, steel sheet.
 - 6. All welded joints shall be ground and dressed to be smooth, flush, and invisible.
- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates of sufficient strength from same material as frames to support hardware without through bolting and to comply with the following minimum sizes:
 - 1. Hinges: Minimum 0.123 inch thick, 10 gage, by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
 - 2. Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick, 14 gage.
 - 3. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick, 14 gage.
 - 4. Fabricate concealed stiffeners and hardware reinforcement plates from same material as frames.
 - 5. Locate hardware reinforcement plates as indicated on approved Shop Drawings or, if not indicated, according to ANSI/SDI A250.6.
- E. Plaster Guards: Formed from same material as frames, not less than 0.016-inch thick, 28 gage, steel sheet to close off interior of openings; place at back of hardware cutouts where mortar or other materials might obstruct hardware operation.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Stud-Wall Type: Slip in wood stud anchor; not less than 0.053 inch thick, 16 gage.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, 18 gage, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.6 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, 22 gage, fabricated from same material as door face sheet in which they are installed.
 - 1. Provide non-removable stops on outside of exterior doors and on secure side of interior doors for glass in doors.
 - 2. Provide screw-applied, removable, glazing stops on inside of glass in doors.
- B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, 22 gage, fabricated from same material as frames in which they are installed.

2.7 ACCESSORIES

- A. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.
- B. Smoke Seals for Smoke Door Frames and Fire-Rated Door Frames: UV-resistant polyethylene clad urethane foam gasket material complying with UL10C with 3 hour fire rating approval.
- C. Weather Stripping for Exterior Door Frames: UV-resistant polyethylene clad urethane foam gasket material.

2.8 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: For exterior locations and elsewhere as indicated, fabricate doors from metallic-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053-inch- thick, 16 gage, metallic-coated steel channels with channel webs placed even with top and bottom edges. Seal joints in top edges of doors against water penetration.
 - 2. Interior Door Faces: Fabricate exposed faces of doors, including stiles and rails of nonflush units, from cold-rolled steel sheet, unless otherwise indicated.
 - 3. Pairs of Doors: Size pairs of doors to provide the following maximum gap between leaves to permit proper functioning of dead latching feature:
 - a. Rated Doors: Maximum 1/8-inch gap.
 - b. Non-Rated Doors: Maximum 3/16-inch gap.
 - 4. Glazed Lites: Factory cut openings in doors.
 - 5. Coordinate door undercut to provide 1/2 inch clearance from top of floor covering. Coordinate locations where ceramic tile floor coverings occur.

- D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 2. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor. Provide floor anchors for all frames. Floor anchors are in addition to jamb anchors.
 6. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.
 7. Door Silencers: Except on weather-stripped doors and kerfed door frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
 8. Provide welded frames with temporary spreader bars for shipping. Shipping spreader bars to be removed before installation, with template jig used to properly square up and space jambs.
- E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated on approved Shop Drawings, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware. Through bolting will not be acceptable.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.
- G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow metal work.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.9 STEEL FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Apply primers to hollow metal doors and frames after assembly.
 2. All interior and exterior doors and frames shall be factory primed to assure proper preparation and bond of primer. Bare galvanized or galvanized steel for field priming not permitted.
- B. Comply with SSPC-PA1, "Paint Application Specification No. 1," for steel sheet finishes.
- C. Metallic-Coated Steel Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
 1. Galvanizing Repair Paint: High-zinc-dust-content paint for reglazing welds in steel, complying with SSPC-Paint 20.
- D. Steel Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel; comply with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.
 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

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

- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. If unacceptable conditions are encountered, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Review finish schedules and verify flooring thickness to permit frame to be set at proper elevation to maintain undercut clearance of factory fit wood and hollow metal doors, providing not less than 1/4 inch clearance from finish floor.
- B. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- C. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.
- D. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames for doors, sidelights, transoms, borrowed lights, and other openings, of size and profile indicated. Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable glazing stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove shipping straps at bottom of frames. Properly space frame using wood template that is full depth of frame and of proper spacing width during setting and

anchoring of frames to maintain proper width, with frame plumb and square without twists. Remove temporary braces necessary for installation only after frames have been properly set and secured. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

- f. Set bottom of frames at required elevations to provide proper undercut clearance of factory fit doors.
 - g. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - h. Field apply bituminous coating to backs of frames that are filled with grout.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors. Floor anchors are in addition to wall anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 3. Stud Partitions: Attach wall anchors to studs with screws. Provide floor anchor at each jamb, in addition to the wall anchors. Use galvanized fasteners at exterior locations.
 4. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
 5. Seals: Install weather stripping and smoke seals in kerfed door frames.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 3. Smoke-Control Doors: Install doors according to NFPA 105.
 4. Pairs of Doors: Install pairs of doors to provide the following maximum gap between leafs and accurate alignment of strike to permit proper functioning of dead latching feature:
 - a. Rated Doors: Maximum 1/8-inch gap.
 - b. Non-Rated Doors: Maximum 3/16-inch gap.
- D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

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SECTION 081416 - WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing wood doors.
3. Factory fitting wood doors to frames and factory machining for hardware.
4. Factory glazing of wood doors with glazed openings.

B. Related Requirements:

1. Division 08 Section "Door Hardware" for hardware and templates, and door hardware preinstallation conference.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to door installation including, but not limited to, the following:

1. Meet with Owner, Architect, door installer, hardware installer, door supplier and door manufacturer's representative. Provide 7 business days minimum advance notice to participants prior to convening preinstallation conference. Door preinstallation conference shall run concurrently with door hardware preinstallation conference.
2. Review methods and procedures related to door installation, including manufacturer's written instructions.
3. Review installation of fire doors, including hinge screw application to fire rated doors and requirements for door removal from frame if required after installation.
4. Review door swing and closer installation to permit maximum swing without binding at frame opening.
5. Review floor covering requirements to provide proper door undercut clearance.
6. Review fire rated door requirements regarding no field modifications to labeled doors.
7. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."

1. Submittals for Division 08 Sections "Hollow Metal Doors and Frames," "Wood Doors," "Aluminum-Framed Entrances and Storefronts," and "Door Hardware" shall be made concurrently.

- B. Product Data: For each type of door. Include details of core and edge construction and trim for openings.
- C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
 - 4. Undercuts.
 - 5. Verify floor tile locations for proper clearance of door bottoms and hardware.
 - 6. Fire-protection ratings for fire-rated doors.
- D. Door Schedule: Submit schedule of doors prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Contract Drawings.
 - 1. Indicate coordination of glazing frames and stops with glass and glazing requirements.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Preinstallation conference meeting notes.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Protect wood doors during transit, storage, and handling to prevent damage, soiling and deterioration. Comply with requirements of referenced standard, manufacturer's instructions, and recommendations of WDMA I.S.1, Appendix, "How to Store, Handle, Finish, Install and Maintain Wood Doors."
 - 1. Package doors at factory prior to shipping.
 - 2. Protect doors from extremes of heat and cold. Relative humidity shall not be less than 30 percent nor more than 60 percent.
 - 3. Compare prefinished doors to approved finish sample upon delivery. Notify Architect if sample does not match.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Algoma Hardwoods, Inc.
 - 2. Eggers Industries.
 - 3. Marshfield Door Systems, Inc.
 - 4. VT Industries, Inc.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."
- B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
- C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C (positive pressure), Category A.
 - 1. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 - 2. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 - 3. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
- D. Smoke-Control Door Assemblies: Listed and labeled for smoke control, based on testing according to UL 1784.
- E. Particleboard-Core Doors:
 - 1. Particleboard: ANSI A208.1, Grade LD-2.

2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
3. Provide doors with structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.

F. Structural-Composite-Lumber-Core Doors:

1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf.
 - b. Screw Withdrawal, Edge: 400 lbf.

G. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - a. Screw-Holding Capability: 550 lbf per WDMA T.M.-10.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces.
2. Species: Select White Maple.
3. Cut: Quarter sliced.
4. Match between Veneer Leaves: Slip match.
5. Assembly of Veneer Leaves on Door Faces: Running match.
6. Pair Match: Provide door faces of compatible color and grain for doors hung in same opening.
7. Exposed Vertical Edges: Same species as faces - edge Type A.
8. Core: Particleboard, except as noted.
 - a. Provide mineral cores for fire-protection rated doors.
 - b. Provide structural composite lumber cores for stile and rail configured doors.
9. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press. No substitution.
10. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

2.4 LIGHT FRAMES

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: Any closed-grain hardwood.
2. Profile: Manufacturer's standard shape.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
4. Glazing beads for rated and non-rated doors shall have the same profile.

- B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.
 - 1. Glazing beads for rated and non-rated doors shall have the same profile.

2.5 GLAZING IN DOORS

- A. Safety Glass for Non-Rated Doors: ASTM C 1048; Kind FT (fully tempered), Condition A (uncoated), Type I (transparent flat glass); Class 1(clear); Quality q3 (glazing select).
 - 1. Thickness: 6.0 mm (0.23 inch) thick minimum.
 - 2. Safety Glazing Labeling: Permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- B. Laminated Ceramic Glazing for Fire-Rated Doors: Laminated glass made from 2 plies of clear, ceramic flat glass; not less than 5/16-inch total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
 - 1. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed.
 - 2. Fire-Protection-Rated Glazing: Listed and labeled by Underwriters Laboratories (UL), for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies.
 - a. Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.
 - 3. Products:
 - a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
 - b. Schott North America, Inc.; Laminated Pyran Platinum L.
 - c. Vetrotech Saint-Gobain; SGG Keralite FR-L.

2.6 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 1. Comply with NFPA 80 requirements for fire-rated doors.
 - 2. Coordinate sizing of pairs of doors to provide the following maximum gap between leaves to permit proper functioning of dead latching feature:
 - a. Rated Doors: Maximum 1/8-inch gap.
 - b. Non-Rated Doors: Maximum 3/16-inch gap.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.

- C. Openings: Factory cut and trim openings through doors.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable installation requirements in Section 088000 "Glazing."

2.7 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:
 - 1. Grade: Custom.
 - 2. Finish: WDMA TR-6 catalyzed polyurethane.
 - 3. Staining: Marshfield stain color, Toast 28-95 or approved equal from other manufacturers..
 - 4. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Division 08 Section "Door Hardware."
 - 1. Hinges shall be shimmed with metal shims at each door to provide equal clearance at each jamb.
 - a. After hinges have been fastened to fire rated doors, do not permit removal and reinstallation of screws to fire rated door edge material.
 - b. Locks, exit devices, door closers and other hardware shall be installed in accordance with the manufacturer's instructions. Pilot holes of recommended size for wood screws required to fasten hardware shall be drilled by installing Contractor before screws are fastened to wood doors.
 - 2. Locks, exit devices, door closers and other hardware shall be installed in accordance with the manufacturer's instructions. Pilot holes of recommended size, for wood screws required to fasten hardware, shall be drilled by installing Contractor before screws are fastened to wood doors.

- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 - 1. Install fire-rated doors according to NFPA 80.
 - 2. Install smoke-control doors according to NFPA 105.

- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge. Coordinate pairs of doors to provide the following maximum gap between leafs and accurate alignment of strike to permit proper functioning of dead latching feature:
 - 1. Rated Doors: Maximum 1/8-inch gap.
 - 2. Non-Rated Doors: Maximum 3/16-inch gap.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.

END OF SECTION 081416

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SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing 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. Wall access doors and frames.
 - 2. Ceiling access doors and frames.
- B. Related Sections include the following:
 - 1. Division 07 Section "Roof Accessories" for roof hatches.
 - 2. Division 23 Sections for heating and air-conditioning duct access doors.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of door and frame indicated. Include construction details, materials, individual components and profiles, and finishes.
- C. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other Work.
- D. Access Door and Frame Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain access door(s) and frame(s) through one source from a single manufacturer.
- B. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.5 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment. Coordinate with architectural, plumbing and mechanical drawings for locations of wall and ceiling access doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 STEEL MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 1. ASTM A 123/A 123M, for galvanizing steel and iron products.
 - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.
- C. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

2.3 STAINLESS-STEEL MATERIALS

- A. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
 - 1. Finish: Directional Satin Finish, No. 4.

2.4 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in 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.

2.5 ACCESS DOORS AND FRAMES

- A. Flush Access Doors and Trimless Frames for Drywall: Fabricated from steel sheet, except as noted. Provide stainless steel sheet for units in walls within toilet rooms, and janitor's closets and for units adjacent to sinks, water closets, urinals and similar fixtures that could cause fluids to come into contact with access door and frame.
 - 1. Locations: Gypsum board wall and ceiling surfaces.
 - 2. Door: Minimum 0.070-inch- thick (14 gage) sheet metal, set flush with surrounding finish surfaces.
 - 3. Frame: Minimum 0.060-inch- thick (16 gage) sheet metal with drywall bead.
 - 4. Hinges: Spring-loaded concealed pin type continuous piano hinge (stainless steel for stainless steel units).

5. Latch: Screwdriver- operated cam latch.
6. Lock: Key-operated cylinder lock in locations accessible by the public.
7. Products:
 - a. J. L. Industries, Inc.; Model WB.
 - b. Karp Associates, Inc.; KDW.
 - c. The Williams Brothers Corporation of America; WB-DW.
 - d. Provide comparable products where stainless steel units are indicated.

2.6 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Steel Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
 1. For trimless frames with drywall bead for installation in gypsum board assembly, provide edge trim for gypsum board securely attached to perimeter of frames.
 2. Provide mounting holes in frames to attach frames to metal framing.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 1. For cylinder lock, furnish two keys per lock and key all locks alike.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.8 STEEL FINISHES

- A. Surface Preparation: 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. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- B. Apply shop primer to uncoated surfaces of metal fabrications. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

2.9 STAINLESS-STEEL FINISHES

- A. Remove tool and die marks and stretch lines or blend into finish.

- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- C. Bright, Directional Polish: No. 4 finish.
 - 1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install access doors with trimless frames flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113

SECTION 083327 - OVERHEAD COILING COUNTER SHUTTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-rated counter shutter.
- B. Related Sections:
 - 1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.
 - 2. Division 26 Sections for electrical service and connections to fire- and smoke-detector systems and for powered operators and accessories.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type and size of overhead coiling counter shutter and accessory. Include the following:
 - 1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
 - 2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
 - 3. For smoke-rated counter shutters, description of smoke-release system including testing and resetting instructions.
 - 4. Installation instructions.
- C. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Summary of forces and loads on walls and jambs.
 - 3. Wiring Diagrams: For power, signal, and control wiring.
- D. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
 - 1. Include similar Samples of accessories involving color selection.
- E. Qualification Data: For qualified Installer signed by manufacturer certifying that Installer complies with specified requirements.

- F. Maintenance Data: For overhead coiling counter shutters to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Source Limitations: Obtain overhead coiling counter shutters as complete units, including operators, controls, hardware, accessories, and mounting/installation components, from single source from single manufacturer.
- C. Fire-Rated Counter Shutter Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 or UL 10B.
 - 1. Smoke Control: Provide shutters that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of shutters opening at 0.10 inch wg for both ambient and elevated temperature tests.
 - a. Comply with NFPA 105 air leakage requirements.
 - b. Counter shutter shall be labeled.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
- F. Operation Cycles: Provide overhead coiling counter shutter components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

PART 2 - PRODUCTS

2.1 FIRE RATED COUNTER SHUTTER

- A. Products:
 - 1. Cookson Company; Auto-Test Tube Motor Operated Counter Fire Door.
 - 2. Cornell Iron Works Inc.; SmokeShield Counter Fire Door Model ERC 11.
- B. Counter Shutter: Fire-rated, electrically operated, overhead coiling shutter fabricated of interlocking slats in a continuous length for width of shutter without splices and having the following characteristics:
 - 1. Shutter Material: ASTM A 653, Commercial Quality, galvanized steel, not less than 22 gage.
 - a. Finish: Manufacturer's powder coat; color as selected by Architect from manufacturer's full range of standard options.

2. Slats: Flat profile slats, minimum 1-1/4-inch center-to-center height, with a bottom bar constructed of tubular extruded steel measuring 2 inches high by 1-1/4 inches deep.
3. Shutter Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
4. Hood: Square; galvanized steel, not less than 24 gage; finished to match curtain.
5. Mounting: Face of wall.
6. Rating: 1-hour.
7. Smoke Seals: Provide UL-listed and -tested smoke-seal perimeter gaskets.
8. Operator: Electric tube motor, maintenance free electric brake, emergency manual crank hoist and control station. Motor shall be protected against overload with an auto-reset thermal sensing device.
 - a. Operator shall be equipped with an emergency manual crank hoist assembly that safely cuts operator power when engaged. A disconnect chain shall not be required to engage or release the manual crank hoist
 - b. Shutters shall maintain an average closing speed of not more than 12 inches per second during automatic closing. When automatic closure is activated, electric sensing edge and push button are inoperable.
 - c. Shutters shall be fail-safe and close upon power failure.
9. Automatic-Closing Device: Equip each smoke-rated shutter with an automatic-closing device or holder-release mechanism and governor unit complying with NFPA 80 and an easily tested and reset release mechanism. Release mechanism shall allow testing without mechanical release of the shutter. Automatic-closing device shall be designed for activation by building fire-detection, smoke-detection, and -alarm systems.
10. Operation Cycles: Not less than 20,000.

2.2 COUNTERBALANCING MECHANISM

- A. General: Counterbalance counter shutters by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Barrel for Tube Motor Shaft Assembly: Steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot of width.

2.3 ELECTRIC COUNTER SHUTTER OPERATORS

- A. General: Electric counter shutter operator assembly of size and capacity recommended and provided by shutter manufacturer for shutter and operation-cycles requirement specified, with electric motor and factory-rewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking shutter, and accessories required for proper operation.
 1. Comply with NFPA 70.
 2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.
- B. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements for Equipment" unless otherwise indicated.
 1. Electrical Characteristics:
 - a. Phase: Single phase.

- b. Volts: 115 V.
 - c. Hertz: 60.
 - d. Motor Horsepower: 1/4 H.P.
 - 2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
 - 3. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate shutter in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 - 4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 - 5. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed
- C. Control Station: Flush mounted, constant pressure, rocker switch; NEMA 1.
- 1. Control station shall be mounted in visible sight of entire shutter opening.
- D. Emergency Manual Operation: Equip each electrically powered counter shutter with capability for emergency manual operation. Design manual mechanism so required force for shutter operation does not exceed 25 lbf.
- E. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- F. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 GALVANIZED-STEEL FINISHES

- A. Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install overhead coiling shutters and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions, final shop drawings, and as specified.
- B. Install overhead coiling counter shutters, hoods, and operators at the mounting locations indicated for each shutter.
- C. Install units plumb and true, free of warp or twist, and within tolerances specified by manufacturer for smooth operation.
- D. Accessibility: Install overhead coiling shutters, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.
- E. Fire-Rated Shutters: Install according to NFPA 80 and NFPA 105.

3.3 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Test counter shutters closing when activated by detector or alarm-connected fire-release system.

3.4 ADJUSTING AND CLEANING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. After completion of installation, including work by other trades, lubricate bearings and sliding parts as recommended by manufacturer.
- C. Restore slight blemishes in finishes in accordance with manufacturer's instructions to match original finish. Remove and provide new units where repairs are not acceptable to Architect.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling shutters.
 - 1. Review data in Maintenance Manuals.
 - 2. Schedule training with Owner with at least 7 days advance notice.

END OF SECTION 083327

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Exterior and interior storefront framing.
2. Exterior and interior manual-swing entrance doors and door-frame units.
3. Interior aluminum door frames to receive wood doors.
4. Interior aluminum borrow lites.
5. Operable window units in storefront.
6. Break metal in conjunction with frames.
7. Door hardware.
8. Extruded-aluminum sun control assemblies.
9. Sealant at interior and exterior perimeter of storefront.

- B. Related Requirements:

1. Division 07 Section "Joint Sealants" for installation requirements of joint sealants installed with aluminum-framed systems and for sealants to the extent not specified in this Section.
2. Division 08 Section "Wood Doors" for wood doors installed in interior storefront.
3. Division 08 Section "Glazed Aluminum Curtain Walls" for curtain-wall systems that mechanically retain glazing on four sides and that receive aluminum entrance doors specified in this Section.
4. Division 08 Section "Glazing" for glazing and spandrel panel requirements to the extent not specified in this Section.

- C. Products installed, but not furnished, under this Section include the following:

1. Balance of door hardware furnished in Division 08 Section "Door Hardware."

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to glazed aluminum storefront and entrance systems including, but not limited to, the following:

1. Meet with Owner; Architect; storefront and entrance systems Installer; storefront and entrance systems manufacturer's representative; and installers whose work interfaces with or affects storefront and entrance systems.
2. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
3. Review structural loading limitations.

4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
5. Review required inspecting, testing, and certifying procedures.
6. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.
7. Review temporary protection requirements for existing construction during and after installation.
8. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
9. Provide minimum advance notice of 5 business days to participants prior to convening preinstallation conference.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Include manufacturer's installation instructions for system(s) specified.
 2. For sealants and sealant primers used inside the weatherproofing system, including printed statement of VOC content.
- B. Shop Drawings: For aluminum-framed entrances and storefronts and sun control assemblies prepared by or under the supervision of a qualified professional structural engineer. Include plans, elevations, sections, full-size details of components, rough openings, masonry openings, flashing, and attachments to other work.
 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 4. Indicate fastener layout and size for transferring loads back to supporting structure.
 5. For entrance and all-glass doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
 1. Initial Selection of Sealant Color: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

- E. Delegated-Design Submittal: For aluminum-framed entrances and storefronts and sun control assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional structural engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer signed by manufacturer certifying that Installers comply with requirements in "Quality Assurance" Article and for professional engineer.
- B. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- C. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified independent testing agency. Tests shall be based on manufacturer's current system and shall indicate compliance with performance requirements.
- D. Manufacturer's Field Reports: Manufacturer's field service representative shall submit field inspection report of product installation to Architect.
- E. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
 - 1. 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 entrance door hardware.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 - 1. Engineering Responsibility: Preparation of data for glazed aluminum storefront systems and sun control assemblies including the following:
 - a. Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.
- B. Professional Engineer Qualifications: A professional structural engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for installations of glazed storefront systems that are similar to those indicated for this Project in material, design, and extent.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated

by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

D. Field Quality Control: Provide manufacturer's field services consisting of product use recommendations, site visit at commencement of work, and periodic site visit for inspection of product installation in accordance with manufacturer's instruction. Manufacturer's field representative shall prepare written report on installation of systems.

1.8 MOCKUPS

A. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Provide a sample installation of a storefront, 24 inches wide by 32 inches high, for masonry mockup panel and on mockup panel for air/vapor barrier; panels built in Division 04 Section "Unit Masonry Assemblies" and Division 05 Section "Cold Formed Metal Framing."
 - a. Mockup shall be completed for review at preinstallation conference.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems and sun control assemblies by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Coordinate rough opening, masonry opening, and wood blocking requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Failure of system to meet performance requirements.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - e. Adhesive or cohesive sealant failures.
 - f. Water penetration through fixed glazing and framing areas.
 - g. Failure of operating components.
 - h. Glazing breakage.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional structural engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts and sun control assemblies.

- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction. Aluminum-framed entrances and storefronts and sun control assemblies shall withstand the effects indicated and the requirements of IBC 2009.
 - 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Deflection exceeding specified limits.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Glass breakage.
 - e. Noise or vibration created by wind and thermal and structural movements.
 - f. Loosening or weakening of fasteners, attachments, and other components.
 - g. Failure of operating units.
 - h. Sealant failure.

- C. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Code: Comply with requirements of IBC 2009.
 - 3. Aluminum storefront assemblies shall be engineered to support all structural loads transferred from the sun control assemblies.

- D. Deflection of Framing Members: At design wind pressure, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

- E. Structural: Test according to ASTM E 330 as follows:
 - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 2. Entrance Doors:
 - a. Pair of Doors: Maximum air leakage of 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
 - b. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
- H. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.
- I. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.69 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.20 as determined according to NFRC 200.
 3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 62 as determined according to NFRC 500.
- J. Structural Performance for Sun Control Assemblies: Provide exterior sun control assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without evidencing permanent deformation of assembly or components including blades, frames, and supports; without disengagement from the glazed system mullion; noise or metal fatigue caused by blade rattle or flutter; or permanent damage to fasteners and anchors:
1. Wind and Snow Loads: As indicated on Structural Drawings.
 2. Combined load on sunshade configurations to be determined in accordance with ASCE 7 or applicable code requirements.
 3. Blade deflection shall not exceed L/120 of span length.
 4. Submit test reports verifying compliance with each test requirement required by the project.
- K. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.

- c. Interior Ambient-Air Temperature: 75 deg F.

2.2 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Kawneer North America:
 - a. Exterior Storefront and Entrances: Trifab 451T frames with 350 Heavy Wall Entrances and Trifab VG 451 Heavy Wall Frames.
 - b. Interior Storefront and Entrances: Trifab VG 451 frames with 350 Heavy Wall Entrances and Trifab VG 451 Heavy Wall Frames.
 - c. Operable Vents: Glassvent Operable Units.
 - d. Sun Control Assemblies: Versoleil Sun Shade - Outrigger System.
 - 2. Oldcastle Building Envelope (Formerly Vistawall):
 - a. Exterior Storefront and Entrances: Series 3000 poured and debridged Thermal Storefront System with Rugged MS Entrances and Thermally Broken Heavy Wall Frames.
 - b. Interior Storefront and Entrances: Series 3000 with Rugged MS Entrances and Non-Thermally Heavy Wall Frames.
 - c. Operable Vents: ZS-2750 Vents.
 - d. Sun Control Assemblies: Solar Eclipse Sun Shade System.
 - 3. Tubelite:
 - a. Exterior Storefront and Entrances: Exterior Storefront and Entrances: T14000 I/O Series frames with Monumental Medium Stile Entrances and Frames.
 - b. Interior Storefront and Entrances: Interior Storefront and Entrances: E14000 frames with Monumental Medium Stile Entrances and Frames.
 - c. Operable Vents: CVW3700 Series Vents.
 - d. Sun Control Assemblies: Custom Maxblock Airfoil Sunshades.
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing, entrance doors, venting windows, borrow lites, and accessories, from single manufacturer.
 - 1. Aluminum-framed entrances and storefront systems specified in this Section and curtain wall system specified in Division 08 Section "Glazed Aluminum Curtain Wall" shall be from same manufacturer.

2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Construction: As follows:
 - a. Exterior Framing Members: Composite assemblies of two separate extruded-aluminum components permanently bonded by an elastomeric material of low thermal conductance
 - b. Interior Framing Members: Nonthermal.
 - 2. Glazing System: Retained mechanically with gaskets on four sides.
 - 3. Glazing Plane: Center.
 - 4. Finish: Clear anodic finish.
 - 5. Provide components having face width indicated on Drawings.
 - 6. Provide thermally broken extruded aluminum subframes.
 - 7. Provide thermally broken extruded aluminum sill flashing with end dams for storefronts.

8. Provide operable units (doors and windows) manufactured by storefront system manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
 - C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
 1. Provide extra-heavy reinforcement for hinges and closers at doors over 7 feet in height.
 - D. Materials:
 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 VENTING WINDOWS

- A. Projected (Awning) Windows: Provide manufacturer's thermally broken, visually frameless, top-hinged, outward swinging window designed for use in storefront system. Finish to match storefront system.
 1. Products:
 - a. Kawneer North America; GlassVent.
 - b. Oldcastle Building Envelope (Formerly Vistawall); ZS 2750.
 - c. Tubelite; CVW3700 Series Windows.
- B. Aluminum Windows: Manufacturer's standard units, complying with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, and as follows:
 1. Window Type: Awning.
 2. Minimum Performance Class: AW.
 3. Minimum Performance Grade: Not less than 40.
 4. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 0.064-inch thickness at any location for main frame and sash members.
 - a. Thermally Improved Construction: Fabricate window units with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
 5. Fasteners, Anchors, and Clips: Nonmagnetic stainless steel, aluminum, or other noncorrosive material, compatible with aluminum window members, trim, hardware, anchors, and other components of window units. Fasteners shall not be exposed, except for attaching hardware.

- a. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.128 inch (3.26 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, spline grommet nuts.
- 6. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:
 - a. Operator: Cam operator; provide two per ventilator.
 - b. Hinges: Comply with AAMA 904; concealed, stainless steel, four-bar friction hinge with adjustable-slide friction shoe; two per ventilator.
 - 1) Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.
 - c. Weather Stripping: Manufacturer's standard compressible, replaceable weather stripping designed for permanently sealing under bumper action around full perimeter of unit, and completely concealed when ventilator is closed.
- 7. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, complying with SMA 1004 or SMA 1201, and as follows:
 - a. Glass-Fiber Mesh Fabric: 18-by-16 or 18-by-14 mesh of PVC-coated, glass-fiber threads, woven and fused to form a fabric mesh; complying with ASTM D 3656.
- C. Glazing: Same as adjacent aluminum-framed entrances and storefront glazing.
- D. Finish: Match adjacent aluminum-framed entrances and storefront finish.

2.5 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual- and power-assisted-swing operation.
 - 1. Door Construction: 2-inch overall thickness, with minimum 0.188-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - 2. Door Design: Wide stile; 5-inch nominal width with 10-inch high bottom rail, and 6-inch cross rail.
 - 3. Door Frame: Minimum 0.188-inch thick, extruded aluminum; 2-inch by 4-1/2 inch profile, stop with weather stripping; run heavy weight jambs full height of opening and transom.
 - 4. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets; finished to match frame.
 - a. Provide nonremovable glazing stops on outside of exterior doors and to nonsecured side of interior doors.

2.6 ENTRANCE DOOR HARDWARE

- A. General: Provide heavy-duty units in sizes, numbers, and types recommended by entrance system and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish, unless otherwise indicated. Provide specified manufacturers without substitution.
 - 1. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

2. Opening-Force Requirements:
 - a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
 - b. Accessible Interior Doors: Not more than 5 lbf to fully open door.
- B. Continuous, Gear-Type Hinges : Heavy-duty, extruded aluminum, pinless, geared hinge leaves; joined by a continuous extruded aluminum channel cap; with concealed, self-lubricating with stainless-steel bearings between knuckles; fabricated to full height of door and frame. Finish to match doors.
- C. Weather Stripping: Manufacturer's standard replaceable components.
 1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC. Provide at head and jamb of all exterior doors for weather control and at all interior doors for smoke control.
- D. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
- E. Silencers: BHMA A156.16, Grade 1.
- F. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch. Coordinate cutouts for operating hardware with anchors and jamb clips.
 1. Material: Aluminum, mill finish.
- G. Balance of Hardware: Furnished in Division 08 Section "Door Hardware."

2.7 GLAZING

- A. Glazing: Provided in Division 08 Section "Glazing."
- B. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L.
- C. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.
 1. Color: As selected by Architect.

2.8 ALL-GLASS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Blumcraft of Pittsburgh; C.R. Laurence Co, Inc.
 2. Oldcastle BuildingEnvelope.
 3. Virginia Glass Products Corporation.
- B. Manual Swing Doors: Single acting swing doors set into aluminum storefront.
 1. Glass: 1/2 inch thick clear tempered. Flat polished edges.

2. Fittings: Patch fittings and pivot corners, 32D brushed stainless steel finish.
3. Hinging: Concealed overhead closer with top pivot, BHMA A156.4, Grade 1; including cases, bottom arms, top walking beam pivots, plates, and accessories required for complete installation. Closer shall allow door to open to maximum available swing before stopping. Adjust closer for ADA compliance.
4. Locking: None.
5. Push and Pull Bars: C.R. Laurence CH24X24BS Crescent Mid-Mount back-to-back 24 inch long handles, 32D finish.

2.9 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 2. Reinforce members as required to receive fastener threads.
 3. Do not use exposed fasteners, except for hardware application. For hardware application, use exposed fasteners with countersunk Phillips screw heads, finished to match framing system or hardware being fastened, unless otherwise noted. Exposed fasteners shall be stainless steel.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.
- E. Aluminum Break Metal: Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness, not less than 0.063-inch thick, to maintain a flat appearance without visible deflection.
- F. Head Compensation Receptor (Deflection Track): Manufacturer's standard, thermally broken head receptor.
- G. Jamb Receptor: Manufacturer's standard, thermally broken receptor.

2.10 FABRICATION

- A. General: Fabricate glazed aluminum storefront system and sun control assemblies according to approved Shop Drawings. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

- B. Form or extrude aluminum shapes before finishing.
- C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- D. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- E. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At exterior doors, provide weather sweeps applied to door bottoms.
- H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- I. Windows: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact. Fabricate units that are reglazable without dismantling sash or ventilator framing.
 - 1. Provide hardware with low conductivity or nonmetallic material for hardware bridging thermal breaks at frame or vent sash.
 - 2. Provide full-perimeter weather stripping for each operable sash and ventilator.
- J. All-Glass Doors: Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
- K. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.11 SUN CONTROL ASSEMBLIES

- A. Sunshades: Exterior, horizontal fixed, extruded-aluminum sun control assemblies that are anchored directly to the vertical storefront mullions. Assemblies shall have the following components:
 - 1. Outriggers: Straight with square edges; size as indicated.
 - 2. Blade: Arch blade, extruded aluminum.
 - a. Number: As indicated; spaced equally on outrigger.
 - b. Shape: Arch.
 - c. Width: As indicated.
 - 3. Fasciae: Rectangular.
 - 4. Finish: Match adjacent glazed aluminum storefront.
 - 5. Fasteners: Stainless steel.

2.12 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Four-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color: Charcoal. Color to match Aluminum Curtainwall.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Confirm that wood blocking, where used, has been sufficiently fastened to transfer storefront wind loads back to structure.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.

2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
 - D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation. Install sills in one piece, full width of opening except where opening exceeds available manufactured lengths. Provide sealed metal end dams at ends of sills. Sills shall turn up on backside to form pan, directing water to the exterior.
 - E. Secure subframes to opening framing. Caulk exterior perimeter with backer rod and sealant. Caulk around interior perimeter between frame and the air/vapor barrier with backer rod and sealant.
 - F. Install components plumb and true in alignment with established lines and grades.
 - G. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
 - H. Install glazing as specified in Division 08 Section "Glazing."
 - I. Install weatherseal sealant according to installation requirements in Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer. Color of sealant to match aluminum finish. Provide sealants around storefront perimeter on interior sides between frame and air/vapor barrier and exterior sides between frame and exterior finishes.
 - J. Entrance Doors and Windows: Install doors and windows to produce smooth operation and tight fit at contact points.
 1. Exterior Doors and Windows: Install to produce weathertight enclosure and tight fit at weather stripping.
 2. Field-Installed Entrance Door and Window Hardware: Install surface-mounted entrance door and window hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
 3. Install hardware furnished in Division 08 Section "Door Hardware," including continuous hinges, power assist door operators, closers, pulls, exit devices, trims and miscellaneous hardware as scheduled.
 - K. All-Glass Doors: Install all-glass systems and associated components according to manufacturer's written instructions. Reinforce aluminum storefront at pivot attachment locations as required.

3.3 ERECTION TOLERANCES

- A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 3. Alignment:

- a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.4 MAINTENANCE SERVICE

A. Entrance Door Hardware:

1. 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 entrance door hardware.

END OF SECTION 084113

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SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following:
 - 1. Conventionally glazed aluminum curtain walls installed as stick assemblies.
 - 2. Structural-sealant-glazed curtain-wall assemblies.
 - 3. Break metal in conjunction with frames.
 - 4. Manufactured trim accessories.
 - 5. Sealant at interior and exterior perimeter of curtain wall.
- B. Related Requirements:
 - 1. Division 07 Section "Composite Wall Panels" for insert panels tied into glazed aluminum curtain wall assembly.
 - 2. Division 07 Section "Joint Sealants" for installation requirements of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
 - 3. Division 08 Section "Aluminum-Framed Entrances and Storefronts" for entrance and storefront systems and for entrances installed in glazed aluminum curtain wall systems.
 - 4. Division 08 Section "Glazing" for insulating-glass and spandrel glass requirements.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to glazed aluminum curtain-wall systems including, but not limited to, the following:
 - 1. Meet with Owner; Architect; curtain wall system Installer; curtain wall system manufacturer's representative; and installers whose work interfaces with or affects curtain wall system.
 - 2. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 - 3. Review structural load limitations.
 - 4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 5. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.
 - 6. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
 - 7. Provide 5 business days minimum advance notice to participants prior to convening preinstallation conference.

1.4 ACTION SUBMITTALS

- A. General: Submit in accordance with Section 013300.
 - 1. Submittals for Sections 084113 and 084113 shall be made concurrently.
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Include manufacturer's installation instructions for system(s) specified.
- C. Shop Drawings: For glazed aluminum curtain walls prepared by or under the supervision of a qualified professional structural engineer. Include plans, elevations, sections, full-size details of components, rough openings, masonry openings, flashing, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- D. Samples for Initial Selection:
 - 1. Samples for Sealants: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- E. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional structural engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer signed by manufacturer certifying that Installers comply with requirements in "Quality Assurance" Article and for professional engineer.
- B. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.
 - 1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
- C. Product Test Reports: For glazed aluminum curtain walls, for tests performed by a qualified independent testing agency. Tests shall be based on manufacturer's current system and shall indicate compliance with performance requirements.
- D. Installation Report: Manufacturer's field service representative shall submit a field inspection report of product installation to Architect.
- E. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 - 1. Engineering Responsibility: Preparation of data for glazed aluminum curtain wall systems including the following:
 - a. Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.
- B. Professional Engineer Qualifications: Professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of glazed aluminum curtain wall systems that are similar to those indicated for this Project in material, design, and extent.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- D. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain wall assemblies.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls and sun control assemblies by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

- A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Air infiltration exceeding specified limits.
 - c. Thermal stresses transferring to building structure.

- d. Glass breakage due to system failure.
 - e. Noise or vibration created by wind and thermal and structural movements.
 - f. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - g. Water penetration through fixed glazing and framing areas exceeding specified limits.
 - h. Failure of operating components.
 - i. Sealant failure.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional structural engineer, as defined in Section 014000 "Quality Requirements," to design glazed aluminum curtain walls.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Air infiltration and water penetration exceeding specified limits.
 - c. Deflection exceeding specified limits.
 - d. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - e. Glass breakage.
 - f. Noise or vibration created by wind and thermal and structural movements.
 - g. Loosening or weakening of fasteners, attachments, and other components.
 - h. Failure of operating units.
 - i. Sealant failure.
- C. Structural Loads:
 - 1. Wind Loads: As indicated on Structural Drawings.
 - 2. Code: Comply with requirements of IBC 2009.
- D. Deflection of Framing Members: At design wind pressure, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 - 3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:

- a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4-inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.
- E. Structural: Test according to ASTM E 330 as follows:
- 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
- 1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft..
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
- 1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..
- H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
- 1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..
- I. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- 1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.
 - 2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.7 at design displacement and 1.5 times the design displacement.
- J. Energy Performance: Certify and label energy performance according to NFRC as follows:
- 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.69 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
 - 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.20 as determined according to NFRC 200.
 - 3. Condensation Resistance: Provide glazed aluminum curtain-wall systems with condensation-resistance factor (CRF) of not less than 66 when tested according to AAMA 1503.
- K. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
- 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 - 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

- a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
- L. Structural-Sealant Joints:
- 1. Designed to produce tensile or shear stress of less than 20 psi.
- M. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
- 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 - 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
- 1. Kawneer North America:
 - a. Curtain Wall System: 1600 Wall System.
 - 2. Oldcastle Glass Building Envelope (formerly Vistawall Architectural Products):
 - a. Curtain Wall System: Reliance.
 - 3. Tubelite:
 - a. Curtain Wall System: 400 Series Curtainwall.
- B. Source Limitations: Obtain all components of curtain wall system, including framing, and accessories, from single manufacturer.
- 1. Glazed aluminum curtain wall systems specified in this Section and aluminum entrances and storefront systems specified in Division 08 Section "Aluminum Entrances and Storefronts" shall be from same manufacturer.

2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
- 1. Construction: Thermally broken.
 - 2. Glazing System:
 - a. Retained mechanically with gaskets on four sides where indicated.
 - b. Retained mechanically with gaskets on two sides and structural sealant on two sides where indicated.
 - 3. Glazing Plane: Front.
 - 4. Finish: Clear anodic finish.
 - 5. Member Size: Not less than 7-1/4 inch by 2-1/2 inch.
- B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
- 1. Include snap-on aluminum trim that conceals fasteners.
 - 2. Include adaptor for tying in insert panel of aluminum composite panel system.

- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 - 2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 GLAZING

- A. Glazing: Comply with Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.
- D. Structural Glazing Sealants: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
 - 1. Color: As selected by Architect from manufacturer's full range of colors.
- E. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
 - 1. Color: As selected by Architect.

2.5 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Do not use exposed fasteners, except for hardware application. For hardware application, use exposed fasteners with countersunk Phillips screw heads, finished to match framing system or hardware being fastened, unless otherwise noted. Exposed fasteners shall be stainless steel.

- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.
- E. Aluminum Break Metal: Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness, not less than 0.063-inch thick, to maintain a flat appearance without visible deflection.
- F. Aluminum Outside Corner: Extruded aluminum, 90 degree outside corner as indicated.
- G. Interior Aluminum Closure Angle: Form from sheet aluminum finished to match framing and of sufficient thickness, not less than 0.125-inch thick, to maintain a flat appearance.
- H. Head Compensation Receptor (Deflection Track): Manufacturer's standard, thermally broken head receptor.

2.6 FABRICATION

- A. General: Fabricate glazed aluminum curtain wall system according to approved Shop Drawings. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- B. Form or extrude aluminum shapes before finishing.
- C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- D. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

- E. Fabricate components to resist water penetration as follows:
 - 1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
 - 2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
- F. Prepare components to receive concealed fasteners, anchors, and connection devices.
- G. Glazing Pockets: Provide minimum clearances for thickness and type of glass indicated according to FGMA's "Glazing Manual."
- H. Curtain-Wall Framing: Fabricate components for assembly using shear-block system.
- I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Four-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color: Charcoal.

2.8 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 - 7. Seal joints watertight unless otherwise indicated.
 - 8. Provide means to drain water to the exterior to produce a permanently weatherproof system.

- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
 - 2. Where aluminum is in contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

- C. Set continuous sill members and flashing in a full sealant bed as specified in Division 07 Section "Joint Sealants" and to provide weathertight construction, unless otherwise indicated. Install sills in one piece, full width of opening except where opening exceeds available manufactured lengths. Provide sealed metal end dams at ends of sills. Sills shall turn up on backside to form pan, directing water to exterior.

- D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

- E. Install components plumb and true in alignment with established lines and grades, without warp or rack.

- F. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

- G. Anchorage: After system components are positioned, fix connections to building structure as indicated on Shop Drawings.
 - 1. Arrange fasteners and attachments to conceal from view.
 - 2. Provide separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

- H. Install glazing as specified in Division 08 Section "Glazing."
 - 1. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

- I. Install weatherseal sealant according to installation requirements in Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
 1. Install backer rod and sealant around exterior of opening, back from cover plate, sealing perimeter weather tight. Install backer rod and sealant around rear of curtain wall frame to inside of rough opening between frame and air/vapor barrier. The intention is to provide a double seal to reduce the chance of water infiltration due to interior negative pressure.
 2. Color of sealant to match aluminum finish.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.5 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure glazed aluminum curtain wall system are without damage or deterioration at time of Substantial Completion. Protect finish, seals, and other components from damage.

END OF SECTION 084413

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SECTION 086300 - METAL-FRAMED SKYLIGHTS

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 aluminum-framed pyramid skylights with the following characteristics:
 - 1. Glazing is glass.
 - 2. Glazing is retained by field-installed pressure caps.
- B. Related Sections include the following:
 - 1. Division 05 Section "Structural Steel Framing" for steel framing that supports skin-system assemblies.
 - 2. Division 07 Section "Sheet Metal Flashing and Trim" for metal flashings installed at perimeters of assemblies.
 - 3. Division 07 Section "Joint Sealants" for sealants installed at perimeters of metal-framed skylights.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide metal-framed skylights, including anchorage, capable of withstanding, without failure, the effects of the following:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure.
 - 4. Dimensional tolerances of building frame and other adjacent construction.
- B. Failure includes the following:
 - 1. Deflection exceeding specified limits.
 - 2. Water leakage.
 - 3. Thermal stresses transferred to building structure.
 - 4. Noise or vibration created by wind and thermal and structural movements.
 - 5. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - 6. Loosening or weakening of fasteners, attachments, and other components.
 - 7. Sealant failure.
- C. Structural Loads:
 - 1. Wind Loads: As indicated by structural design data on Drawings.
 - 2. Snow Loads: As indicated by structural design data on Drawings.
 - 3. Concentrated live loads usually represent weight of personnel performing maintenance on metal-framed skylights or adjacent roof areas. Skylights with glazing that cannot support

concentrated live loads may require protective screens or covers; see "Protection" Article in the Evaluations.

4. Concentrated Live Loads: 250 lbf applied to framing members at locations that will produce greatest stress or deflection.
5. Seismic Loads: As indicated by earthquake design data on Drawings.
6. Load Combinations: Calculate according to IBC 2009.

D. Deflection of Framing Members:

1. Deflection Normal to Glazing Plane:
 - a. Spans Up to 20 Feet: Limited to 1/175 of clear span or 1 inch, whichever is smaller.
 - b. Glass Edge Deflection: Limit edge deflection of individual glass lites to 3/4 inch.
2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.

E. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

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

1.4 PERFORMANCE TESTING

A. Provide metal-framed skylights that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.

B. Structural-Performance Test: ASTM E 330.

1. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity but not less than 10 seconds.

C. Air-Infiltration Test: ASTM E 283.

1. Minimum Static-Air-Pressure Difference: 6.24 lbf/sq. ft..
2. Maximum Air Leakage: 0.06 cfm/sq. ft..

D. Test for Water Penetration under Static Pressure: ASTM E 331.

1. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..
2. Water Leakage: None.

E. Condensation Resistance: Provide aluminum-framed systems that when tested with fixed glazing, have a frame condensation-resistance factor (CRF) of not less than 54 when tested according to AAMA 1503 when clear over clear insulated is used.

1.5 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed skylights.
- C. Shop Drawings: For metal-framed skylights. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Fabrication Sample: Of each framing intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
 - 1. Joinery.
 - 2. Anchorage.
 - 3. Glazing.
 - 4. Flashing and drainage.
- E. Qualification Data: For the following:
 - 1. For Installer: Signed by skylight manufacturer certifying that Installer is approved by manufacturer to install skylights.
 - 2. For Professional Engineer.
- F. Welding Certificates: Signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for metal-framed skylights.
- H. Maintenance Data: For metal-framed skylights to include in maintenance manuals.
- I. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Entity capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
- B. Professional Engineer Qualifications: Professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of skylights that are similar to those indicated for this Project in material, design, and extent.
- C. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to metal-framed skylights including, but not limited to, the following:

1. Meet with Owner, Architect, skylight Installer, skylight manufacturer's representative, and installers whose work interfaces with or affects skylight installation including installers of roofing.
2. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
3. Review structural load limitations.
4. Review skylight curb structural requirements.
5. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
6. Review weather and forecasted weather conditions and procedures for unfavorable conditions.
7. Review protection of adjacent roof areas and roofing repair procedures.
8. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
9. Provide 5 business days minimum advance notice to participants prior to convening preinstallation conference.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.

1.8 WARRANTY

- A. Skylight Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-framed skylights that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals and other materials beyond normal weathering.
 - d. Adhesive or cohesive sealant failures.
 - e. Water leakage.
 2. Warranty Period: Five years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Product: Pinnacle 300 Model Extended Pyramid; Wasco Products, Inc.; phone: 800-388-0293.
 1. Type: Aluminum-framed pyramid skylights in size and configuration as indicated on drawings.

2.2 FRAMING SYSTEMS

- A. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B 209.
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
- B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
 - 1. Include snap-on aluminum trim that conceals fasteners.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.
- D. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.
 - 1. At pressure caps, use ASTM A 193/A 193M, 300 series stainless-steel screws.
 - 2. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 - 3. Exposed Fasteners:
 - a. Use exposed fasteners with countersunk Phillips screw heads.
 - b. Finish exposed portions to match framing system.
 - 4. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
- E. Anchor Bolts: ASTM A 307, Grade A, hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- F. Concealed Flashing: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- G. Exposed Flashing and Closures: Manufacturer's standard aluminum components as follows:
 - 1. Apron Flashing: Not less than 0.032 inch thick.
 - 2. Closures: Not less than 0.062 inch thick.
- H. Framing Gaskets: Manufacturer's standard.
- I. Framing Sealants: As recommended in writing by manufacturer.
 - 1. Provide sealants for use inside of the weatherproofing system that comply with the requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda or Greenguard Children & Schools Certification Program by Greenguard Environmental Institute.

2.3 GLAZING SYSTEMS

- A. Glazing: Factory-assembled insulating glass units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
 - 1. Type: Low-e-coated, clear insulating laminated glass units.
 - 2. Overall Unit Thickness: 1-1/8 inch.

3. Outdoor Lite: Fully tempered float glass complying with ASTM C 1048; Type I; Quality-Q3; Class I (clear); 1/4-inch thick.
 4. Interspace: Air filled; 1/2-inch thick.
 5. Indoor Lite: Clear laminated glass, 3/8-inch thick, complying with ASTM C 1172 with two plies of fully tempered float glass.
 6. Low-E Coating: On third surface.
 7. Provide safety glazing labeling.
- B. Spacers, Setting Blocks, and Gaskets: Manufacturer's standard elastomeric types.
- C. Glazing Sealants: As recommended in writing by manufacturer.
1. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other components with which it comes in contact; and recommended in writing by structural- and weatherseal-sealant and metal-framed skylight manufacturers for this use.

2.4 ACCESSORY MATERIALS

- A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.5 FABRICATION

- A. Fabricate aluminum components before finishing.
- B. Fabricate aluminum components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
 4. Physical and thermal isolation of glazing from framing members.
 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
- C. Fabricate aluminum sill closures with weep holes and for installation as continuous component.
- D. Reinforce aluminum components as required to receive fastener threads.
- E. Weld aluminum components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- F. Field Glazing: Locate and size extruded elastomeric setting blocks and spacers in accordance with the glazing manufacturer's recommendations. At no point shall the glazing come in contact with the skylight frame or fasteners.
- G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.6 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 - 7. Seal joints watertight, unless otherwise indicated.
- B. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
- C. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
- D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
- E. Install components plumb and true in alignment with established lines and elevations.
- F. Field Glazing: Locate and size extruded elastomeric setting blocks and spacers in accordance with the glazing manufacturer's recommendations. At no point shall the glazing come in contact with the skylight frame or fasteners.

- G. Install secondary-sealant weatherseal according to sealant manufacturer's written instructions to provide weatherproof joints. Install joint fillers behind sealant as recommended by sealant manufacturer.
- H. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:
 - 1. Alignment: Limit offset from true alignment to 1/32 inch where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches; otherwise, limit offset to 1/8 inch.
 - 2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet but no greater than 1/2 inch over total length.

3.3 CLEANING

- A. Clean exposed skylights surfaces inside and outside, immediately after installation and after sealants have cured, according to manufacturer's written recommendations.
- B. Remove excess sealants, glazing materials, dirt, and other substances according to sealant manufacturer's written recommendations.
- C. Remove and replace glazing that has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect skylight surfaces from contact with contaminating substances resulting from construction operations.

END OF SECTION 086300

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:
 - a. Swinging doors.
 - 2. Cylinders for doors specified in other Sections.
 - 3. Electrified door hardware.
Includes all low voltage wire and wiring of electronic hardware to interface with Access Control System.
- B. Related Sections include the following:
 - 1. Division 08 Section "Hollow Metal Doors and Frames" metal door hardware prep and door preinstallation conference.
 - 2. Division 08 Section "Wood Doors" for wood door hardware prep and door preinstallation conference.
 - 3. Division 08 Section "Aluminum Entrances and Storefronts" for partial entrance door hardware.
 - 4. Division 08 Section "Access Control Hardware" for access control system for electronic door hardware.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
 - 1. Submittals for Sections 081113, 081416, 084113, 87100 and 087413 shall be made concurrently.
- B. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: Details of electrified door hardware, indicating the following:
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. System schematic.
- D. Samples: For exposed door hardware of each type indicated below, in specified finish, full size. Tag with full description for coordination with the Door Hardware Schedule. Submit samples before, or concurrent with, submission of the final Door Hardware Schedule.
 - 1. As requested by Architect.

2. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
- E. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
 - a. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Description of each electrified door hardware.
 - i. Provide hardware for every door in the project, except as indicated, so that each door functions correctly for its intended use. Where a door is not included in the Door Hardware Schedule at end of Part 3, provide hardware scheduled for similar type opening and review with Architect.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- F. Keying Schedule: Meet directly with the Owner to review hardware function and keying requirements before ordering hardware. Prepare keying schedule by or under the supervision of supplier, detailing Owner's final keying instructions for locks.
- G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
1. Include lists of completed projects with project names and addresses of architects and owners, and other information specified.
- H. Maintenance Data: For each type of door hardware to include in maintenance manuals specified in Division 01.
- I. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. **Supplier Qualifications:** Door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 - 1. **Scheduling Responsibility:** Preparation of door hardware and keying schedules.
- C. **Architectural Hardware Consultant Qualifications:** A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
 - 1. Architectural hardware consultant shall be a full time employee of the hardware supplier, shall be located within 2 hours driving time of the project site, and participate in job site meetings, keying and hardware function reviews, coordination and field examination of installed hardware.
- D. **Source Limitations:** Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
- E. **Pre-Ordering Meeting:** Before ordering hardware, have a meeting with the Contractor, Owner and Architect to review hardware functions, door swing clearances and closer requirements, requirements and conflicts with hold open devices, electronic locking, door stops and other similar hardware requirements affecting the use and operation of each opening.
 - 1. Prepare a list of questions and potential conflicts and distribute to the Architect 5 days before the meeting.
 - 2. Shop drawings, including door and frame shop drawings and door hardware schedule shall be furnished to the Architect at least 10 days before the meeting.
 - 3. Review each door on the project and record meeting notes regarding any coordination, modifications and changes. Submit meeting minutes within 3 days of meeting date.
- F. **Conditions and Coordination:** Hardware supplier shall determine conditions and materials of ~~all~~ doors and frames for proper application of hardware.
 - 1. The Hardware Schedule shall list the actual product series numbers. Hardware supplier shall follow manufacturers' catalog requirement for the actual size of door closers, brackets and holders. Door opening sizes are as noted on the Door and Frame Schedule and hardware shall be in strict accordance with requirements of height, width, and thickness.
- G. **Regulatory Requirements:** Comply with provisions of the following:
 - 1. Comply with all applicable codes. Comply with Americans with Disabilities Act (ADA), as follows:
 - a. **Handles, Pulls, Latches, Locks, and other Operating Devices:** Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
 - 1) Operable parts of such hardware shall be 34 inches minimum and 48 inches maximum above the finish floor or ground.

- b. Door Closers: Comply with the following maximum opening-force requirements indicated:
 - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
 - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - c. Thresholds (Public Traffic Doors): Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.
 - 2. NFPA 101: Comply with the following for means of egress doors:
 - a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
 - b. Door Closers: Not more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.
 - c. Thresholds (Public Traffic Doors): Not more than 1/2 inch high.
- H. Fire-Rated Door Assemblies: Provide door hardware for 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 and NFPA 101 without exception. Provide only hardware tested by UL for the type and size of door installed and fire resistance rating required.
 - 1. UL 10C - Positive Pressure Test of Fire Door Assemblies Test Pressure: Test at atmospheric pressure.
- I. Keying Conference: Conduct conference directly with the Owner. 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. Requirements for key control system.
 - 3. Address for delivery of keys.
- J. Preinstallation Conference: Conduct conference at Project site with hardware supplier, hardware installer, and electrical subcontractor to comply with requirements in Division 01 Section "Management and Coordination." Door hardware preinstallation conference shall run concurrently with door preinstallation conference. Review methods and procedures related to door hardware including, but not limited to, the following:
 - 1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review required testing, inspecting, and certifying procedures.
 - 4. Review proper installation procedures for locksets, exit devices and closers with Installer and Hardware Supplier.
 - 5. Coordinate on site inspection of installed hardware, including proper installation of closers for degree of swing, allowing doors to open to door stops without binding.

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 Schedule, and include basic installation instructions with each item or package.
- C. Deliver keys to Owner by registered mail or overnight package service.

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, detection devices, and access controls.

1.7 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of operators.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Warranty Period for 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.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section, and the Door Hardware Schedule at the end of Part 3.
 - 1. Door Hardware: Provide quantity, item, size, finish or color indicated, and named manufacturer's products.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

2.2 HINGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hinges:
 - a. Hager Companies.
 - b. McKinney Products Company.
 - c. Stanley Commercial Hardware; Div. of The Stanley Works.
- B. Standards: Comply with the following:
 - 1. Butts and Hinges: BHMA A156.1.
 - 2. Template Hinge Dimensions: BHMA A156.7.
- C. Quantity: Provide the following, unless otherwise indicated:
 - 1. Two Hinges: For doors with heights up to 60 inches.
 - 2. Three Hinges: For doors with heights 61 to 90 inches.
 - 3. Four Hinges: For doors with heights 91 to 120 inches.
 - 4. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
- D. Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

Maximum Door Size (inches)	Hinge Height (inches)	Metal Thickness (inches)	
		Standard Weight	Heavy Weight
40 and under by 1-3/4	4-1/2	0.134	0.180
Over 40 by 1-3/4	5	0.146	0.190

- E. Hinge Weight: Unless otherwise indicated, provide the following:
 - 1. Entrance Doors: Heavy-weight hinges.
 - 2. Interior Stair Doors: Heavy-weight hinges.
 - 3. Cross Corridor and Vestibule Doors: Heavy-weight hinges.
 - 4. Doors with Closers: Antifriction-bearing hinges.
 - 5. Interior Doors without closers: Standard-weight hinges, oil-impregnated bearings unless specified otherwise.
- F. Hinge Base Metal: Unless otherwise indicated, provide the following:
 - 1. Exterior Hinges: Stainless steel, with stainless-steel pin.
 - 2. Interior Hinges: Steel, with steel pin.
 - 3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.
- G. Hinge Options: Comply with 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 the following applications:
 - a. Outswinging exterior doors.
 - b. Outswinging interior doors with locks.
 - 2. Corners: Square.
 - 3. Coordinate hinge requirements and reinforcement with aluminum door supplier.

- H. Fasteners: Comply with the following:
 - 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 - 2. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
 - 3. Screws: Phillips flat-head screws; machine screws (drilled and tapped holes) for metal doors. Finish screw heads to match surface of hinges.
 - 4. Stainless steel for stainless steel hinges.
- I. Electrified Functions for Hinges: Comply with the following:
 - 1. Power Transfer: Concealed PTFE-jacketed wires, secured at each leaf and continuous through hinge knuckle.
 - 2. Available Products:
 - a. Hagar: ETW 4-1/2 x 4-1/2.
 - b. McKinney: TA2714-CC4.
 - c. Stanley: CEFBB-179.

2.3 LOCKS AND LATCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mechanical Locks and Latches:
 - a. Corbin Russwin Architectural Hardware.
 - b. Sargent Manufacturing Company.
 - c. Schlage Lock Company.
 - 2. Electrified Locking Devices shall be Schlage CO-200 series with proximity credential readers and key over ride Model Number CO-200 MS 70 PR RHO 626 PD C123 13-049 X 10-025 1 3/4 or approved equal by Sargent.
- B. Bored Locks: Heavy duty locks with lever handles, deadlocking latch bolt, core to receive Medeco cylinder provided by Owner, BHMA A156.2, Grade 1; Series 4000.
 - 1. Corbin Russwin: CL3300 Series, Lever design NZD – Newport, core to receive Medeco cylinder, 3-1/2-inch Rose, ANSI Curved Lip Strike.
 - 2. Sargent: 10-Line, Lever design LB, 3-1/2-inch Rose, core to receive Medeco cylinder, ANSI No. 88 Curved Lip Strike.
 - 3. Schlage: D-Lever Series, Lever design Rhodes RHO, 3-1/2-inch Rose, core to receive Medeco cylinder, ANSI Curved Lip Strike 10-025.
- C. Auxiliary Locks: BHMA Grade 1.
- D. Lock Trim: Comply with the following:
 - 1. Lever: Forged or Cast.
 - 2. Escutcheon (Rose): Wrought, forged, or cast.
- E. Lock Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:
 - 1. Minimum 3/4-inch latchbolt throw.
- F. Deadbolts: Minimum 1-inch bolt throw. Backset: 2-3/4 inches, unless otherwise indicated.

2.4 DOOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Surface Bolts:
 - a. Glynn-Johnson; an Ingersoll-Rand Company.
 - b. Ives: H. B. Ives.
 - c. Rockwood Manufacturing Company.
 2. Flush Bolts:
 - a. Door Controls International (DCI).
 - b. Glynn-Johnson; an Ingersoll-Rand Company (GJ).
 - c. Ives: H. B. Ives (IVS).
 - d. Rixson-Firemark, Inc.; Div. of Yale Security Inc. (RIX).
 - e. Rockwood Manufacturing Company (RM).
- B. Standards: Comply with the following:
1. Surface Bolts: BHMA A156.16.
 2. Automatic and Self-Latching Flush Bolts: BHMA A156.3.
 3. Manual Flush Bolts: BHMA A156.16.
- C. Surface Bolts: BHMA Grade 1.
1. Flush Bolt Heads: Minimum of 1/2-inch- diameter rods of brass, bronze, or stainless steel with minimum 12-inch- long rod for doors up to 84 inches in height. Provide longer rods as necessary for doors exceeding 84 inches.
- D. Flush Bolts: BHMA Grade 1, designed for mortising into door edge.
- E. Bolt Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:
1. Surface Bolts: Minimum 7/8-inch throw.
 2. Fire-Rated Surface Bolts: Minimum 1-inch throw; listed and labeled for fire-rated doors.
 3. Mortise Flush Bolts: Minimum 3/4-inch throw.
- F. Strikes: Provide matching strikes for heads of doors. Provide dust proof strikes at all floor locations.

2.5 EXIT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Sargent Manufacturing Company.
 2. Von Duprin.
 3. Stanley Security Solutions.
- B. Products: All exit devices for this project shall be one of the following:
1. Stanley Apex Series.
 - a. Provide Narrow Stile Apex Series devices for aluminum doors.
 2. The 80 Series exit device by Sargent & Co.
 - a. Provide narrow design 8500 Series for aluminum doors.
 3. 98 Series by Von Duprin Division
 - a. Provide narrow design 35A Series Series for aluminum doors.

- C. 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. Non-rated devices shall have cylinder dogging and exterior cylinder. Provide one leaf with exterior cylinder at pairs of doors.
 - 1. Levers to match locksets standard levers as scheduled.
 - 2. At electric room, provide Stanley Apex Series, Sargent 30 Series or Von Duprin 22 Series.
- D. Fire Exit Devices: Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
- E. Outside Trim: Lever with cylinder; Cylinder at doors scheduled to receive pulls; material and finish to match locksets, unless otherwise indicated.
 - 1. Match design for locksets and latchsets, unless otherwise indicated.
- F. Electrified Exit Devices: Provide devices that provide electrified trim functions and coordinate with Access Control System.
 - 1. Interior exit devices shall be fail safe.

2.6 CYLINDERS AND KEYING

- A. Available Manufacturers: Medeco.
 - 1. Cylinders: Medeco cylinders .
 - 2. Key Control Systems:
 - a. Key Control Systems, Inc.
 - b. Sargent Manufacturing Company.
 - c. Sunroc Corporation.
 - d. Lund.
- B. Standards: Comply with the following:
 - 1. Key Control System: BHMA A156.5.
- C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.
- D. Keying System: Prepare keying schedule with the Owner.
- E. Keys: Nickel-silver keys complying with the following:
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."
 - 2. Quantity: In addition to one extra blank key for each lock, provide the following:
 - a. Cylinder Change Keys: Three for each cylinder keyed differently; Six for each set keyed alike; Four for sets where only two cylinders are keyed alike.
 - b. Master Keys, Grand Master Keys: Six for each set.

2.7 STRIKES

- A. Manufacturers: Same manufacturer as lock, latch and device bolt engaging into strike.
- B. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated.
- C. Electric Strikes: Von Duprin 6000 Series, heavy duty, 24VDC; ANSI/BHMA Grade 1 1500 pounds static strength, 70 ft lbs dynamic strength; stainless steel construction; plug connectors.
 - 1. Steel Hardware Mullion – Rim Exit Device: 6300 surface mounted electric strike.
 - 2. Hollow Metal Frame – Rim Exit Device: 6100 cutout mounted electric strike.

2.8 OPERATING TRIM

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burns Manufacturing Incorporated.
 - 2. NT Quality Hardware.
 - 3. Rockwood Manufacturing Company.
 - 4. HDI Door Hardware; Handrail Design Inc.
- C. Standard: Comply with BHMA A156.6, solid bar, stainless steel 32D.
- D. Materials: Fabricate from stainless steel, unless otherwise indicated.
 - 1. Decorative Pulls: HDI Door Hardware; Series 2000, No. 2430, 19-11/16 inches overall length, 32D.
 - 2. Door Pulls (General Use): 1 inch diameter by 10 inches long.
 - Rockwood BF111
 - Burns BF26C
 - Quality BF163-10"
 - 3. Push Bars: 1inch diameter, full width of door.

2.9 ACCESSORIES FOR PAIRS OF DOORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Coordinators:
 - a. Door Controls International (DCI).
 - b. Glynn-Johnson; an Ingersoll-Rand Company (GJ).
 - c. Hager Companies (HAG).
 - d. Rockwood Manufacturing Company (RM).
 - 2. Removable Mullions: BHMA A156.3, steel. Powder coat finish to match aluminum doors.

- C. Removable Mullions: Provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.
 - 1. Removable mullions shall be keyed.
 - 2. Electrified mullions shall have quick disconnect twist apart plug connectors.

2.10 CLOSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Surface-Mounted Closers:
 - a. LCN Closers; an Ingersoll-Rand Company.
 - b. Sargent Manufacturing Company.
- B. Standards: Comply with the following:
 - 1. Closers: BHMA A156.4.
- C. Surface Closers: BHMA Grade 1, cast-iron body.
 - 1. Door closers shall have fully hydraulic, full rack and pinion action. Cylinder body shall be 1-1/2" in diameter, and double heat treated pinion shall be 11/16" in diameter.
 - 2. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and hydraulic back-check.
 - 3. All closers shall have heavy (extra) duty solid forged steel main arms (and forged forearms for parallel arm closers).
 - 4. Closer arms shall have a powder coating finish.
 - 5. Provide drop, mounting plates for aluminum doors, and where required.
 - 6. Do not locate closers on the side of doors facing corridors, passageways or similar type areas. Where it is necessary, due to certain conditions and approval of the Architect, to have closers in corridors, provide such closers with parallel or track type arms.
 - 7. Door closers shall be adjusted by the installer in accordance with the manufacturer's templates and written instructions. Closers with parallel arms shall have back-check features adjusted prior to installation.
 - 8. Closers shall conform to all applicable code and law requirements relative to setting closing speeds for closers and maximum pressure for operating interior and exterior doors.

Models:	LCN	Sargent
Exterior	4111S-CUSH	281 - CPS
	4111S--CUSH	281 - CPSH
Interior	4011	281 - 0
	4111	281 - P10
	4111S-CUSH	281 - CPS
	4111S-H-CUSH	281 - CPSH
	4040SEL	2468
Interior (Service, Mechanical, Electric only)	1461	1431

- D. Swing: Allow door to swing to the maximum degree opening allowable for the swing condition. Where doors with closers do not have a bumper stop, provide closer with CUSH-N-STOP feature. Do not allow leading edge of door to swing into the path of an adjacent door opening.
- E. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.11 POWERED DOOR OPERATORS

- A. Electrically - Powered Door Operator
 - 1. Referenced Standard: Provide unit that conforms to AAMA/BHMA A156.19 low energy operation, and to ADA Architectural Guidelines for opening force and time to close standards.
 - 2. Products: Subject to compliance with requirements, furnish one of the following products:
 - a. Horton 4000 LE, No substitution.
 - 3. General: Furnish complete system, including electro-mechanical swinging door operator and solid-state electronic control, aluminum header matching door frame, connecting hardware, and power on/off switch.
 - 4. Operator: Opening by means of a fractional HP DC motor, through reduction gears, splined spindle, door arm and linkage assembly. If door encounters an obstacle, operator shall stop the door in the open position by electrically reducing the motor voltage and stalling. Spring closing, with closing speed controlled by the motor operating as a dynamic brake. Operator shall function as a manual door closer in the direction of swing, with or without electrical power.
 - a. Operator shall be removable from the header as a unit, for servicing and replacement.
 - b. Door Speed and Timing:
 - 1) Door opening time: Adjustable but not less than 4 seconds.
 - 2) Door closing time: Adjustable but not less than 4.5 seconds.
 - 3) Hold Open: Adjustable from 6 to 60 seconds, to allow safe passage between series of doors at entrance and vestibule.
 - c. Furnish unit without power assist ("Push-N-Go") feature, or with device that allows Owner to activate or disconnect the feature after the door has been installed.
 - 5. Header: 0.125 minimum wall thickness extruded aluminum.
 - 6. Metal Finish: Finish covers, mounting plates, and arm system with manufacturer's standard powder-coat finish. Match finish of storefront framing system.
 - 7. Push-Plate Control: Nominal 4 inch square or 4-1/2 inch diameter round push-plate control; recessed box wall mounting; stainless steel with No. 4 satin finish; with international accessibility symbol engraved and painted blue.
 - a. Vestibule Dual Push-Plate: BEA 10PBDGP1.
 - 8. Presence Sensor: Overhead diffused active infrared presence sensor that can sense moving and stationary objects, protecting swing path and threshold protection until object has fully cleared swing path of door. BEA Bodyguard, header-mounted presence sensor.
 - 9. Pedestal: Type 304 brushed stainless steel, 6 inches by 4 inches by .120 wall tube thickness, 48 inches high, sloped top with rounded edges, 6 inch by 10 inch rear access panel. Provide custom cut-out size for vestibule dual push-plate. Provide four stainless steel chemical anchors for attachment to concrete slab.
 - a. Pedestal CEO, 800-660-3072.

2.12 PROTECTIVE TRIM UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Metal Protective Trim Units:
 - a. Burns Manufacturing Incorporated.
 - b. Don-Jo Mfg., Inc.
 - c. Rockwood Manufacturing Company.
- B. Standard: Comply with BHMA A156.6.
- C. Materials: Fabricate protection plates from the following:
 - 1. Stainless Steel: 0.050 inch thick; beveled top and 2 sides.
- D. Fasteners: Provide manufacturer's oval head exposed fasteners for door trim units consisting of either machine or self-tapping screws, for installation in counter sunk holes.
- E. Furnish protection plates sized 2 inches less than door width on push side by the following height:
 - 1. Kick Plates: 8 inches
 - 2. Push Plates: 8 inches wide by 16 inches high.

2.13 STOPS AND HOLDERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Glynn-Johnson; an Ingersoll-Rand Company.
 - 2. Hager Companies.
 - 3. Ives: H. B. Ives.
 - 4. Rixson-Firemark, Inc.
 - 5. Rockwood Manufacturing Company.
- B. Standards: Comply with the following:
 - 1. Stops and Bumpers: BHMA A156.16.
 - 2. Electromagnetic Door Holders: BHMA A156.15.
 - 3. Door Silencers: BHMA A156.16.
- C. Stops and Bumpers: BHMA Grade 1.
 - 1. Wall Stops: Convex with concealed mounting.
 - 2. Floor Stops: Dome stop, base thickness to accommodate flooring thickness.
- D. Electromagnetic Door Holders: Coordinate with fire detectors and interface with fire alarm system. Coordinate mounting and projection requirements to hold back door to the maximum swing possible.
- E. Wall Stops: For doors, unless floor or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic.
 - 1. Where floor or wall stops are not appropriate, provide heavy duty overhead holders.
 - a. Glynn-Johnson GJ90-32D, unless indicated otherwise.
 - 2. Where concealed overhead stops are scheduled, provide Glynn-Johnson GJ410F-32D

- F. Silencers for Metal Door Frames: BHMA Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame.

2.14 DOOR GASKETING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Door Gasketing and Door Bottoms:
 - a. National Guard Products, Inc.
 - b. Pemko Manufacturing Co., Inc.
 - c. Reese Enterprises, Inc.
 - d. Zero International, Inc.
- B. 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 UL 10B or NFPA 252.
 - 1. Astragal Smoke Seals: Pemko 29310CPK, concealed fastener.
- C. Sound-Rated Gasketing:
 - 1. Head and Jamb Perimeter Surface Applied Seals: Surface applied adjustable perimeter seals, equal to NGP models indicated.
 - 2. Automatic Door Bottom: Automatic drop seal, equal to NGP models indicated.
- D. Kerf smoke seals and weatherstripping specified in Section 081113 - Hollow Metal Doors and Frames.

2.15 THRESHOLDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. National Guard Products, Inc.
 - 2. Pemko Manufacturing Co., Inc.
 - 3. Reese Enterprises, Inc.
 - 4. Zero International, Inc.
- B. Standard: Comply with BHMA A156.21.
- C. General: Extruded aluminum, depth as required for sill condition. Where thresholds extend out beyond face of frame, provide returned closed ends by miter cutting on a 45 degree angle and return to face of frame.
 - 1. Height: 1/2 inch ADA compliant.
 - 2. Provide half-saddle threshold where butting carpet, entrance matting and ceramic tile, 1/4 inch or 1/2 inch height to match height of adjacent finish.

2.16 FABRICATION

- A. 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 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

- B. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Steel Machine or Wood Screws: For the following fire-rated applications:
 - a. Mortise hinges to doors.
 - b. Strike plates to frames.
 - c. Closers to doors and frames.
 - 3. Spacers or Sex Bolts: For through bolting of hollow metal doors.
 - 4. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.17 FINISHES

- A. Standard: Comply with BHMA A156.18.
- 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.
- D. BHMA Designations: Comply with base material and finish requirements indicated by the following:
 - 1. BHMA 626 (US26D): Satin chromium plated over nickel, over brass or bronze base metal.
 - 2. BHMA 630 (US32D): Satin stainless steel, over stainless-steel base metal.
- E. With the exceptions of exit devices, door closers, plates, push bars, pulls, thresholds and weatherstripping, all hardware items shall be furnished in dull chrome finish 26D or brushed stainless steel 32D.
 - 1. Exceptions are as follows:

Exit Devices:	32D
Door Closers:	Sprayed Aluminum
Plates:	32D
Pulls:	32D
Hardware Mullions:	Powder coat finish to match aluminum frame color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall 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. If errors in dimensions or preparation are encountered, they are to be corrected by the responsible parties prior to the installation of hardware.
- 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 SDI 107.
- B. Wood Doors: Comply with DHI A115-W series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically 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. 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 9 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.
- C. Exit devices shall be carefully installed so as to permit friction free operation of crossbar, touch bar and lever. Latching mechanism shall also operate freely without friction or binding. Verify vertical rods stay in the retracted positions and do not rub on the floor.
- D. Key Control System: Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.
- E. Thresholds: Set thresholds for exterior doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

- F. Door closers shall be installed in accordance with the manufacturer's instructions. Each door closer shall be carefully installed, on each door, at the degree of opening dictated by the frame condition relative to adjacent construction and clearances to permit full swing of the door to the door stops. Arm position shall be as shown on the instruction sheets.
 - 1. The adjustments for all door closers shall be the installer's responsibility and these adjustments shall be made at the time of installation of the door closer. The closing speed and the latching speed valves shall be adjusted individually to provide a smooth, continuous closing action without slamming. The delayed action feature or back check valve shall also be adjusted so as to permit the correct delayed action cycle or hydraulic back check cushioning of the door in the opening cycle. All valves shall be properly adjusted at the time of installation. Each door closer has adjustable spring power capable of being adjusted, in the field, from size 1 thru 6. It shall be the installer's responsibility to adjust the spring power for each door closer in exact accordance with the spring power adjustment chart illustrated in the door closer installation sheet packed with each door closer.

- G. Coordinate installation of hinges in wood doors to prevent requiring the removal and reinstallation of screws into the edges. Do not remove screws after they have been installed on fire rated doors. Provide proper torque on screws without over tightening and stripping.

- H. Prior to Substantial Completion, the installer, accompanied by representative of the supplier of latchsets and locksets, closers, door control devices, and other major hardware, shall perform the following work:
 - 1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements. Review the location of door closers and verify door closers are properly installed for the degree of swing required to permit maximum opening range of the door without binding or stress that could damage doors and frames. Verify arm position is at proper location.
 - 2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
 - 3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.

3.4 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.
 - 1. Door Closers: 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 from the latch, measured to the leading edge of the door. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements. Review the location of door closers and verify door closers are properly installed for the degree of swing required to permit maximum opening range of the door without binding or stress that could damage doors and frames. Verify arm position is at proper location.
 - 2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
 - 3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units

3.5 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 door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.7 DOOR HARDWARE SETS

- A. The hardware sets listed below indicate the items of hardware required for each opening. It is the bidders responsibility to accurately furnish the proper quantities, items, sizes, weights and functions as required by the plans and specifications. If an opening has, through error, been omitted from the following hardware sets, it shall be the bidder's responsibility to supply hardware of equivalent quality and quantity, as that which is specified for a comparable opening.

3.8 DOOR HARDWARE SCHEDULE

Heading 1

Main Entry - Pair Aluminum Exterior

Doors: 101A, 102A

Each Opening Shall Have: Narrow Design Rim Exit Devices, Powered Door Operator (one leaf only), Push-Plate Controls (Push-Plate in Exterior Pedestal, Dual Push-Plate in Vestibule Pedestal), Pedestals, Presence Sensor, Closer w/Drop Plate, Hardware Mullion, Decorative Pulls, Electronic Strike, Cylinders.

Balance of door hardware provide in Section 084113.

Coordinate Door Hardware with Access Control System.

Heading 2

Vestibule – Pair Aluminum

Doors: 101B, 102B

Each Opening Shall Have: Push Bars, Decorative Pulls, Powered Door Operator (one leaf only), Push-Plate Control, Presence Sensor, (Vestibule push-plate and pedestal provided in Heading 1), Closer w/Drop Plate, Cylinders

Balance of door hardware provide in Section 084113.

Heading 3

Entry - Single Aluminum Exterior

Door: 120A, 141B, 143B, 145B, 147B

Each Leaf Shall Have: Narrow Design Rim Exit Device, Closer w/Drop Plate, Pull, Electronic Strike at Door 120A, Cylinders

Balance of door hardware provide in Section 084113.

Heading 4

Entry - Pair Aluminum Exterior

Door: C02B

Each Opening Shall Have: Narrow Design Rim Exit Devices, Closers w/Drop Plate, Hardware Mullion, Pulls, Electronic Strike, Cylinders

Balance of door hardware provide in Section 084113.

Coordinate Door Hardware with Access Control System.

Heading 5

Single HM Exterior

Doors C03A

Each Leaf Shall Have: Hinges, Exit Device (Exterior Cylinder only), Closer, Kick Plate, Weather stripping, Door Bottom, Sweep, Threshold, Cylinders

Heading 6

Pair HM Exterior

Doors 126C, 126D

Each Leaf Shall Have: Hinges, Exit Device (Exterior Cylinder only), Closer, Kick Plate, Weather stripping, Door Bottom, Sweep, Threshold, Hardware Mullion, Cylinders

Heading 7

Entry – Pair, WD x AL

Doors: 126A, 126B

Each Opening Shall Have: Exit Device with cylinder (Classroom Function), Decorative Pulls, Closer w/Drop Plate, Concealed Drop Seal, Kick Plates, Fire Rated Smoke Seals. Cylinders

Balance of door hardware provide in Section 084113.

Heading 8

Entry – Single, WD x AL
Doors: 104A, 149A

Each Opening Shall Have: Lockset (Classroom), Concealed Drop Seal, Kick Plates, Sound Gasketing

Balance of door hardware provide in Section 084113.

Heading 9

Entry – Single, WD x AL
Doors: C04

Each Opening Shall Have: Lockset (Classroom), Cylinder, Kick Plates, Electric Strike, Closer

Balance of door hardware provide in Section 084113.

Heading 10

Office - Single WD x HM
Doors: 108, 109, 110, 111, 112, 113, 114, 116, 117, 118, 119, 121, 134, 138, 140

Each Door Shall Have: Hinges, Lockset (Office Function - Lock Toggle on Edge of Door), Cylinder, Wall Stop

Kerf seals provided in Section 081113.

Heading 11

Double Egress Pair WD x HM
Doors: C02A

Each Opening Shall Have: Hinges, Narrow Design Rim Exit Device with Trim, Electric Strike, Closers (Cush Stop), Electromagnetic Hold Open, Kick Plates, Fire-Labeled Gasketing,

Coordinate Door Hardware with Access Control System).

Heading 12

Mechanical, Custodial – Single WD x HM
Doors: 129, 135

Each Door Shall Have: Hinges, Lockset (Storeroom Function), Cylinder, Wall Stop, Silencers

Heading 13

Utility – Single WD x HM
Doors: 130A, 130B, 131A, 131B, C03B

Each Door Shall Have: Hinges, Lockset (Classroom Function), Cylinder, Wall Stop, Kick Plate, Silencers

Heading 14

Single Toilets – Single WD x HM
Doors: 106, 122, 136, 137

Each Door Shall Have: Hinges, Lockset (Privacy Function), Cylinder, Wall Stop, Silencers

Heading 15

Children's Doors – Single WD x HM
Doors: 133B, 142A, 144, 146, 147C, 148

Each Door Shall Have: Hinges, Latchset (Passage Function), Stop, Silencers

Heading 16

Single Showers – Single WD x HM
Doors: 105A, 107A

Each Door Shall Have: Hinges, Lockset (Privacy Function), Dead Bolt, Cylinder, Wall Stop, Silencers

Heading 17

Classroom – Single WD x HM
Doors: 132, 133, 141A, 141C, 143A, 145A, 145C, 147A

Each Door Shall Have: Hinges, Lockset (Classroom Function), Cylinder, Concealed Automatic Drop Seal, Wall Stop

Kerf seals provided in Section 081113.

Heading 18

Classroom – Double WD x HM
Doors: 149B

Each Door Shall Have: Hinges, Lockset (Classroom Function), Cylinder, Concealed Automatic Drop Seal, Wall Stop

Kerf seals provided in Section 081113.

Heading 19

Gang Toilet – Single WD x HM
Doors: 105, 107

Each Door Shall Have: Hinges, Push Plate, Pull Plate, Closer, Kick Plate, Silencers, Wall Stop

Heading 20

Storage – Single WD x HM
Doors: 115, 121A, 125, 126E, 128B, 139

Each Door Shall Have: Hinges, Lockset (Storeroom Function), Cylinder, Surface Bolt, Stops, Silencers

Heading 21

Storage – Pair WD x HM
Doors: 127A, 127B, 128A

Each Door Shall Have: Hinges, Lockset (Storeroom Function), Cylinder, Closer (128A only), Surface Bolt, Stops, Silencers

Heading 22

Conference – Single WD x HM
Doors: 104B

Each Door Shall Have: Hinges, Lockset (Office Function), Cylinder, Closer, Concealed Drop Seal, Sound Gasketing

END OF SECTION 087100

SECTION 087413 - ACCESS CONTROL 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. Provide the following:
 - 1. Provide a highly secure, easy-to-use and dependable Access Control System (ACS). The ACS shall provide the speed and flexibility of 32-bit multiple-technology controllers and be managed by a client/server application using an intuitive graphical operator interface on the Microsoft Windows 2007, 2008 operating devices, card readers, key fobs, alarm input and output systems. The ACS shall include all computer hardware and software, field controllers, communication boards, power supplies, and all other equipment as indicated on the contract drawings and as specified herein. All material shall be the manufacturer's standard catalog products.
 - 2. Provide a complete Video Intercom system including hardware and wiring.
 - 3. Provide a complete Video Management system including network video recorder, cameras and wiring.
- B. Related Sections include the following:
 - 1. Division 07 Section "Penetration Firestopping" for firestopping penetrations through rated construction.
 - 2. Division 08 Section "Doors Hardware" for door hardware controlled by Access Control System.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Shop drawings shall detail all connected devices, of sufficient detail to adequately communicate that recommended software meets requirements, including:
 - a. System device locations on architectural floor plans.
 - b. Full schematic wiring information for all devices with wiring information including cable type, conductor routings, quantities, and connection details at devices.
 - c. A complete system one-line block diagram.
 - d. System sequence operation description.
- B. Product Data:
 - 1. Submittals shall include manufacturer's data for all material and equipment, including terminal devices, local processors, computer equipment, access cards, and any other equipment required for the complete ACS.
 - 2. Submittals shall include a description of the operating system and application software.

3. Submittals shall include system description, including analysis and calculations used in sizing equipment, and also indicating how equipment will operate as a system. The following information shall be supplied as a minimum:
 - a. Computer host configuration and memory size.
 - b. Description of site equipment and its configuration.
 - c. Backup / archive system size and configuration.
 - d. System power requirements and UPS sizing.
 - e. A description of the operating system and application software.

C. Contract Close-Out Submittals:

1. Provide one bound set of manuals including:
 - a. Operating instructions.
 - b. Maintenance recommendations.
 - c. Parts list, including wiring and connection diagrams.

D. Manuals:

1. Security Contractor shall submit for prior approval [specify number] copies of manufacturer's manual for programming, maintaining and operating the ACS and related components. Final copies of the manual shall be bound in hardback, loose-leaf binders and delivered within thirty (30) days after completing the installation test.
2. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each Security Contractor installing the system and equipment as well as the nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix.
3. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance.
4. The manuals shall contain the following:
 - a. Installation Guide. This manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy and specific functions.
 - b. Operator's Guide. The operator's manual shall fully explain all procedures and instructions for the operation of the system.

E. As-Built Drawings:

1. During system installation, the Security Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the ACS to be used for record drawings.
2. As-built drawings shall be accurately kept up to date by the Security Contractor with all changes and additions.

1.4 QUALITY ASSURANCE

- A. Access Control System Hardware: Hardware supplier shall employ an individual knowledgeable in electrified components and systems, which is capable of producing wiring diagrams and consulting as needed. Coordinate installation of the access control system hardware with the Architect, electrical engineers, intrusion system contractor and electrical contractor and provide installation and technical data and other related subcontractors. Upon completion of access control system hardware installation, inspect and verify that all

components are working properly. Installer shall be fully equipped service organization readily available to provide timely response to service calls for the completed system.

1. Prior to performing any programming, coordinate with the Owner and obtain the Owner's specific programming requirements. Advise Owner in writing, of the scheduled date for commencement of programming. Provide the Owner the opportunity to assist in development of programming details.
2. Set up system and initial programming of the system and cards to be included in the base installation cost of the system.
3. Witness final system test and then certify with an affidavit that the system is installed in accordance with the contract documents and is operating properly.
4. Training and Programming: In addition to the system set up and initial programming, provide a minimum of 24 working hours for the following:
 - a. Train facility personnel on the operation and maintenance of the system (1, two hour session).
 - b. Modifications to the initial programming of the system.
 - c. System use assistance and service call procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened undamaged containers with identification labels intact.
- B. Storage materials protected from exposure to harmful environmental conditions and at temperature conditions recommended by manufacturer.
- C. Handle products and systems in accordance with manufacturer's instructions.

1.6 WARRANTY

- A. Access Control System Warranty:
 1. Provide one year warranty period in accordance with the contract documents. Include the following as part of the access control system warranty.
 - a. Warranty shall include all preventive maintenance suggested by the original equipment manufacturer. Preventive maintenance shall include but not be limited to an annual preventative maintenance check of all system components, which will include all cleaning, adjustments and necessary repairs.
 - b. Warranty shall include a manufacturer's software maintenance agreement and shall include all software updates, revisions, on-line support and telephone service assistance. The software maintenance agreement shall include training for any changes in operation due to the nature of the software revisions.
 - c. Provide written notice to the Owner documenting any Work performed during the warranty period. Repair or replacement service during the warranty period will be performed in the accordance with the following schedule:
 - 1) 8:00am – 5:00pm business days, excluding holidays, twenty four hour response time.
 - d. The Owner reserves the right to expand or add to the system during the warranty period. The Owner may use a separate installer other than the original installer without affecting the original Installer's responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the system being expanded.

PART 2 - PRODUCTS

2.1 DOOR ACCESS CONTROL AND MONITORING SYSTEM (ACS)

A. Base System:

1. Access control will be provided on 4 doors. (see door schedule)
2. System controllers to be located in lower level mechanical space.
3. 50 Key FOBs will be provided.
4. System will be set up for access control and door monitoring. All exterior doors will be monitored for door position or alarm condition

B. ACS shall provide the speed and flexibility of 32-bit multiple-technology controllers and be managed by a client/WEB Client/server/ application using an intuitive graphical operator interface on Microsoft Windows operating system. The ACS shall include all computer hardware and software, field controllers, communication boards, power supplies, low voltage wiring and all other equipment required for a complete, operable system. All material shall be the manufacturer's standard catalog products.

1. Manufacturers: Sielox LLC.
 - a. Access Control Manufacture shall be in business a minimum 15 years manufacturing access control controllers, software, and readers.
2. ACS shall be a 32-bit native Microsoft Windows 2007, 2008, application with multi-operator and multi-threaded (multi-tasking) capability, allowing independent activities and monitoring to occur simultaneously at different locations. Full WEB based or Hosted Access Control Systems are not acceptable.
 - a. WEB Client work station shall be easy to use and employ intuitive icon based operator interface.
 - b. Software shall be designed to support the manufacturer's past and present generation access control hardware and additional OEM components. ACS shall allow ODBC database access either through a defined ODBC interface or an SDK library set. ACS shall conform to standard networking protocols, including: Ethernet, TCP/IP (Ethernet) and NetBEUI.
 - c. Any workstation shall have the ability to display up to four independently configured viewers, each with its own title, filter, columns, and cardholder image display.
 - d. System shall provide full WEB client capabilities and supporting any WEB browser, such as Internet Explorer, Safari, Firefox, etc. Security for the WEB Client shall be at a minimum 256-bit AES encryption.
 - e. All core ACS hardware and software shall be developed and manufactured by the same manufacturer. Provide software of the most current type and revision. Where licensing of the software is required, the license shall be assigned to the Owner. Provide a copy of the software on media to the Owner prior to system acceptance.
3. ACS software and Controllers shall support the following features:
 - a. First person rule for automatic unlocks/lock with multiple time intervals.
 - b. Email on alarms or any event driven action.
 - c. Unlimited access groups.
 - d. Unlimited Time Zones each with eight intervals each.
 - e. Minimum of 2,000 users per Access Control Controller.
 - f. 32 Holidays.
 - g. Password protected administrators and unlimited configurations for operators.
 - h. System shall provide Muster Reports.

- i. Minimum 200 (filtered) standard reports.
 - j. Auto database backup.
 - k. Minimum 99 alarm Levels with full detailed response description with audio.
 - l. Auto activation and expiration for users.
 - m. Time and attendance interface.
 - n. Individual expiring access levels per card holder.
 - o. Full CCTV integration.
 - p. Graphical maps.
 - q. Unlimited cardholder custom fields with minimum of 256 characters.
 - r. Local, regional, and global input/output linking.
 - s. Event filtering with email capabilities.
 - t. Photo ID.
 - u. Scheduler for recurring functions, i.e. auto door unlocks and auto lock, reports, and similar automated controls.
 - v. System shall support 64 access points for expansion and 2,568 inputs/outputs.
 - w. Each access control door controller shall hold at minimum 10,000 transactions in its on-board data storage without communication to the host.
 - x. Controllers shall accept TCP/IP communication directly to the controller.
 - y. Anti-pass back.
 - z. Secure communications via 3DES, 168-bit encryption minimum.
4. Access Controllers:
- a. Access control controllers shall be of the two door type controllers for ease of expansion and cost. Systems that utilize a master controller with door expansions from the master system/controller will not be accepted.
 - b. Door controllers shall be Distributed Processing with real time clock on board each controller with battery back-up for memory for a period of 3 months. In addition to memory back-up Controllers shall support at a minimum, two hours of complete operation in the event of a power outage.
 - c. Controllers shall be UL 294 and 1076 or ETL Certified to the UL Listing.
5. Card Reader: Flush mount, HID ThinLine II low profile proximity reader.
- a. Key Fobs: HID Proximity Key Fobs.
 - 1) Quantity: 50 key fobs.
 - 2) No printing of badges is required
6. PC Workstation Computer: Provide monitor, CPU and keyboard that can be used to program all access control functions, generate reports, display in real-time all or selected alarms, operator instructions for alarm response, alarm resets, all or selected valid and invalid entry activity, and all internal system status alarms such as communication loss/restore, power loss etc.
7. Magnetic Switch: Low voltage magnetic switch and low voltage wire to from magnetic switch to access controller by access control installer, sends notice to door access software of a door violation event.
8. Low Voltage Wire: Size, type and configuration for the equipment, distance and connections required.

2.2 VIDEO INTERCOM SYSTEM

- A. Provide 2 video intercom door stations. Aiphone JP series
- B. Provide 1 desk mounted console master stations

- C. Provide 2 remote lock release per plans
- D. Manufacturers: Aiphone

2.3 VIDEO MANAGEMENT SYSTEM

- A. Provide system to include one Tribrid Network Video Recorder (NVR), keyboard and mouse, monitor, 6 IP 1080P, IR dome exterior rated cameras, low voltage wiring, terminations, initial programming, check out and test, and Owner training.
- B. Size DVR for 8 cameras, recording 30 days at 10 IPS minimum, 40% motion
- C. A networked video recorder (NVR) will be located in the mechanical space on the lower level. Power, network, and internet connections will need to be provided by others.
- D. Manufacturers: Winic

PART 3 - EXECUTION

3.1 ACCESS CONTROL SYSTEM INSTALLATION

- A. Install system components and appurtenances in accordance with the manufacturer's instructions. Furnish all necessary materials, interconnections, services, and adjustments required for a complete and functioning operable system.
 - 1. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Access control system inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors. Access control system communications equipment shall be protected against surges induced on any communications circuit. Cables and conductors which serve as communications circuits from security console to field equipment, and between field equipment, shall have surge protection circuits installed at each end.
 - 2. Low voltage cabling shall comply with Division 26 Electrical. Low voltage wiring outside the control console, cabinets, boxes, and similar enclosures, shall be plenum rated where required by code. Protect cable from damage when passing through building structure or conduit system. Provide bushings wherever cable enters sleeves, conduit, junction boxes, equipment backboxes, and control enclosures. Cables shall be neatly bundled and supported and attached to structure. Cable bundles shall be limited to a maximum of 12 cables, individual bundles of cables shall be separated by at least 2 inches in all directions. Cables loosely laid across top of ceilings or loosely strung through joist are not permitted. Do not attach cable directly to underside of metal roof decking.
 - 3. System Labeling: Provide labeling and numbering required for all components and wiring for the project. Wiring conductors connected to terminal strips shall be individually numbered and each cable or wiring group being extended from a panel or cabinet to a building mounted device shall be identified with the name and number of the particular device.

4. Boxes and enclosures containing security system components and/or cabling and which are easily accessible to employees or to the public shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible.
5. Provide mounting hardware as required for equipment.

3.2 VIDEO INTERCOM SYSTEM INSTALLATION

- A. Install system components and appurtenances in accordance with the manufacturer's instructions. Furnish all necessary materials, interconnections, services, and adjustments required for a complete and functioning operable system.

3.3 VIDEO MANAGEMENT SYSTEM INSTALLATION

- A. Install system components and appurtenances in accordance with the manufacturer's instructions. Furnish all necessary materials, interconnections, services, and adjustments required for a complete and functioning operable system.

END OF SECTION 087413

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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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Doors.
 - 2. Glazed curtain walls.
 - 3. Storefront framing.
 - 4. Glazed entrances.
 - 5. Interior borrowed lites.
 - 6. Mirrors.
 - 7. Decorative glazing film.
- B. Related Sections:
 - 1. Division 08 Section "Wood Doors" for factory glazing of wood doors with glazed openings.
 - 2. Division 08 Section "Glazed Aluminum Curtain Walls" for structural glazing sealants.

1.3 DEFINITIONS

- A. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- B. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.5 ACTION SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."

- B. Product Data: For each glass product and glazing material indicated.
- C. Glass Samples: For each type of the following products; 12 inches square.
 1. Coated spandrel glass.
 2. Fire-resistive glazing products.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass and glazing products, from manufacturer.
 1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.
- B. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE

- A. Source Limitations for Glass: Obtain coated float glass, mirrored glass, fire-rated glazing, spandrel glass, and insulating glass from single source from single manufacturer for each glass type.
- B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
- C. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
 3. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
- D. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- E. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.
- F. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
 - 1. Protect fire-resistive glazing from ultraviolet light.
- B. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- C. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F.
 - 2. Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.10 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty on Fire-Rated Glass: Manufacturer's standard form in which fire rated glass manufacturer agrees to replace fire rated glass units that deteriorate within specified warranty period. Deterioration of fire rated glass is defined as failure defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning fire rated glass contrary to manufacturer's written instructions. Defects include obstruction of glass area, delamination, or edge separation and/or changes in properties of the interlayer.
 - 1. Warranty Period: Five years from date of Substantial Completion.

- D. **Manufacturer's Special Warranty on Mirrors:** Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
1. **Warranty Period:** Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. **Thickness:** Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
1. **Minimum Glass Thickness for Exterior Lites:** Not less than 6.0 mm.
- B. **Strength:** Where float glass is indicated, provide annealed float glass. Where fully tempered glass or safety glazing is indicated or required by code, provide Kind FT heat-treated float glass.

2.2 GLASS PRODUCTS

- A. **Float Glass:** ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. **Safety Glass (Fully Tempered):** ASTM C 1048; Kind FT (fully tempered), Condition A (uncoated), Type I (transparent flat glass); Class 1(clear); Quality q3 (glazing select); conforming to ANZI A97.1.
- C. **Solar Control, Sputter-Coated Float Glass:** ASTM C 1376, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified.
1. **Products:**
 - a. **Guardian Industries Corporation;** SuperNeutral 68.
- D. **Ceramic-Coated Spandrel Glass:** ASTM C 1048, Kind FT (fully tempered), Condition B, Type I, Quality-Q3, and complying with other requirements specified.
1. **Glass:** Clear, fully tempered.
 2. **Ceramic Coating Color:** As selected by Architect from manufacturer's full range.

2.3 SILVERED FLAT GLASS MIRRORS

- A. **Glass Mirrors, General:** ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.
- B. **Clear Glass:** Mirror Glazing Quality; nominal thickness of 6.0 mm.

2.4 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
 - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
 - 2. Spacer: Manufacturer's standard warm edge spacer material and construction.
 - 3. Desiccant: Molecular sieve or silica gel, or blend of both.
- B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.
- C. Low-E, Clear, Insulated Glass Units:
 - 1. Overall Unit Thickness:
 - a. For Exterior Locations Other Than Doors: Inner and outer panes of 6.0 mm glass; total unit thickness of 1 inch minimum.
 - b. For Exterior Doors: Inner and outer panes of 3/16 inch clear glass; total unit thickness of 5/8 inch minimum.
 - 2. Outdoor Lite: Class 1 (clear) float glass, except as noted.
 - a. Kind FT (fully tempered) where indicated or required by code.
 - 3. Interspace Content: Air.
 - 4. Indoor Lite: Class 1 (clear) float glass, except as noted.
 - a. Kind FT (fully tempered) where indicated or required by code.
 - 5. Low-E Coating: Sputtered on second surface.
 - 6. Visible Light Transmittance: 68 percent minimum.
 - 7. Visible Light Reflectance Outdoors: 11 percent.
 - 8. Direct Solar Energy Reflectance Outdoors: 32 percent.
 - 9. Winter Nighttime U-Factor: 0.29 maximum.
 - 10. Summer Daytime U-Factor: 0.28 maximum.
 - 11. Shading Coefficient: 0.43 maximum.
 - 12. Solar Heat Gain Coefficient: 0.38 maximum.
 - 13. Provide safety glazing labeling on fully tempered glass.
- D. Ceramic-Coated, Low-E Insulated Spandrel Glass Units for Concealed Locations:
 - 1. Overall Unit Thickness: 1 inch.
 - 2. Thickness of Each Glass Lite: 6.0 mm.
 - 3. Outdoor Lite: Class 1 (clear), Kind FT (fully tempered) Class 1 (clear) float glass, except as noted.
 - 4. Interspace Content: Air.
 - 5. Indoor Lite: Class 1 (clear), Kind FT (fully tempered).
 - 6. Low-E Coating: [Sputtered on second surface.
 - 7. Opaque Coating Location: Fourth surface.

2.5 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by Underwriters Laboratories (UL) or a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.

- B. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
 - b. Schott North America, Inc.; Laminated Pyran Crystal.
 - c. Vetrotech Saint-Gobain; SGG Keralite FR-L.
 - 2. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed, and permanently labeled by a testing and inspecting agency.

2.6 OBSERVATION GLASS

- A. Laminated One-Way Observation Glass: ASTM C 1172, Kind LM and complying with the following requirements:
 - 1. One lite complying with ASTM C1048, Kind FT (fully tempered), Condition B (spandrel glass, one surface ceramic coated), Type I (transparent, flat); Class 2 (tinted heat-absorbing and light-reflecting); Quality q3 (glazing select); Style B (lower light transmittance); 3 mm (0.115 inch) minimum thickness.
 - a. Color: Gray.
 - b. Process: Pyrolytic on number 2 side.
 - c. Light Transmittance: 12 percent.
 - d. Light Reflectance: 60 percent.
 - 2. One lite of clear glass, ASTM C 1048; Kind FT (fully tempered), Condition A (uncoated), Type I (transparent flat glass); Class 1 (clear); Quality q3 (glazing select); conforming to ANSI Z97.1; 3 mm (0.115 inch) minimum thick.
 - 3. Interlayer: Polyvinyl butyral with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
 - a. For polyvinyl butyral interlayers, laminate lites in autoclave with heat plus pressure.
 - 4. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.
 - 5. Total Thickness: 1/4-inch.
 - 6. Location: Borrowed light between the following rooms:
 - a. Office 134 to Infant 133
 - b. Office 140 to Nursery 141

2.7 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 - 1. EPDM complying with ASTM C 864.
 - 2. Silicone complying with ASTM C 1115.
 - 3. Thermoplastic polyolefin rubber complying with ASTM C 1115.

2.8 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units,

- and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 791 or 795.
 - b. GE Advanced Materials - Silicones; SilPruf NB SCS9000 or UltraPruf II SCS2900.
 - c. Pecora Corporation; 895.
 - d. Tremco Incorporated; Spectrem 2 or Spectrem 3.
- C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.9 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.10 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 for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

- D. Spacers: Elastomeric blocks or continuous extrusions of 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. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.
- H. Mirror Edge Sealer: Coating compatible with glass coating and approved by mirrored glass manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- I. Mirror Mastic: An adhesive setting compound, produced specifically for setting mirrored glass by spot application, certified by both mirrored glass manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrored glass will be installed.
 - 1. Adhesive (mastic) shall have a VOC content of 70 g/L or less.
- J. Stainless Steel Mirror Trim: J-channels formed with a return deep enough to produce a glazing channel to accommodate mirrored glass units of thickness indicated and in lengths required to cover each edge of mirrored glass unit in a single piece; miter corners.
 - 1. Product: C. R. Laurence Co., Inc.; Model SS960 Type "J" Channel.

2.11 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Grind smooth and polish exposed glass edges and corners.

2.12 FABRICATION OF MIRRORED GLASS

- A. Mirror Sizes: To suit Project conditions, cut mirrors to final sizes and shapes.
- B. Silvering: Successive layers of chemically deposited silver, electrically or chemically deposited copper, and manufacturer's standard organic protective coating applied to second glass surface to produce coating system complying with FS DD-M-411.
- C. Mirror Edge Treatment: Flat polished.
 - 1. Seal edges after edge treatment to prevent chemical or atmospheric penetration of glass coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance. Protect glass edges as follows:
 - 1. Use a rolling block in rotating glass units to prevent damage to glass corners.
 - 2. Do not impact glass with metal framing.
 - 3. Use suction cups to shift glass units within openings. Do not raise or drift glass with a pry bar.
 - 4. 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.
- D. Apply primers to joint surfaces where required for adhesion of sealants.

- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, 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 lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to 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 where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings 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.

3.7 MIRROR INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
- B. Provide a minimum air space of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 1. Top and Bottom Stainless Steel J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.

3.8 CLEANING AND PROTECTION

- A. Protect exterior glass from damage 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. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing 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 buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Do not permit edges of mirrors to be exposed to standing water.
- E. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- F. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.
- G. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088000

SECTION 092950 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum wallboard.
 - 2. Tile backing panels.
 - 3. Non-load-bearing steel framing.
 - 4. Interior suspension systems.
 - 5. Acoustical insulation in metal-framed assemblies.
 - 6. Acoustical sealants.
 - 7. Firestopping at wall and partition perimeters of fire-rated construction.
- B. Related Sections include the following:
 - 1. Division 05 Section "Cold-Formed Metal Framing" for load-bearing and curtain wall steel framing and glass-mat gypsum sheathing.
 - 2. Division 06 Section "Rough Carpentry" for concealed wood blocking in gypsum board assembly walls .
 - 3. Division 07 Section "Penetration Firestopping" for systems installed in openings in walls and floors with and without penetrating items.
 - 4. Division 07 Section "Fire-Resistive Joint Systems" for fire-resistive joints not covered by work of this Section.
 - 5. Division 07 Section "Joint Sealants" for sealants not covered by work of this Section.
 - 6. Division 09 Section "Painting" for coordination/inspection requirements with painting contractor and primers applied to gypsum board surfaces.

1.3 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
 - 1. VOC Content of Sealants and Firestopping: Include a printed statement of the VOC content.

- C. Shop Drawings: Show locations, fabrication, and installation of control joints including plans, elevations, sections, details of components, and attachments to other units of Work.
 - 1. Submit marked up floor plans with location of all control joints in gypsum board walls and ceilings.
 - 2. Firestopping: For each joint condition where fire-rated walls and partitions interface other walls, floors, structural members or other building structure, provide UL firestop system description and drawing. Show each kind of construction condition and relationships to adjoining construction. Indicate which firestop materials will be used where and thickness for different hourly ratings. Include UL firestop design designation that evidences compliance with requirements for each condition.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory," GA-600, "Fire Resistance Design Manual," or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.
 - 2. Deflection Firestop Track: Top runner indicated in fire-resistance-rated assemblies shall be labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Source Limitations for Steel Framing: Obtain steel framing members for gypsum board assemblies from a single source from a single manufacturer.
- C. Source Limitations for Panel Products: Obtain each type of gypsum board and other panel products from a single source from a single manufacturer.
- D. Source Limitations for Finishing Materials: Obtain finishing materials from either manufacturer supplying gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.
- E. Gypsum Board Finish Mockups: Before finishing gypsum board assemblies, install mockups using room designated by Architect to demonstrate aesthetic effects and qualities of materials and execution.
 - 1. Install mockups for surfaces indicated to receive nontextured paint finishes.
 - 2. Simulate finished lighting conditions for review of mockups.
 - 3. Mockup will be painted under Division 09 Section "Painting" to provide finished condition for viewing.
 - 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
- C. Stack gypsum panels flat on leveled supports off floor or slab to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
- D. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F. Do not exceed 95 deg F when using temporary heat sources.
- E. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 NON-LOAD-BEARING STEEL FRAMING, GENERAL

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized, unless otherwise indicated. Substitute coatings not allowed.

2.3 STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Manufacturers:
 - 1. Clark Dietrich Building Systems.

2. Marino\Ware.
 3. Super Stud Building Products, Inc.
- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0625-inch-diameter (8-gage) wire, or double strand of not less than 0.099-inch-diameter (12-gage) wire.
- C. Hanger Attachments to Concrete: As follows:
1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.
- D. Hangers: As follows:
1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter (8-gage).
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch, a minimum 1/2-inch-wide flange, with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
1. Depth: 2 inches, unless indicated otherwise.
- F. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep; where indicated.
 - a. Minimum Base Metal Thickness: 0.0312 inch (22 gage).
 2. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical, with face attached to single flange by a slotted leg (web).
- G. Hand-Formable Radius Tracks: Factory fabricated runner track, providing smooth, non-segmented continuous one-piece shape; 0.0329 inch thick, 20 gage; size as indicated.
1. Products: Provide the following products by Radius Track Corporation, (888) 872-3487:
 - a. Hand-Formable Ready-Track.
- H. Grid Suspension System for Interior Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock, heavy-duty.
1. Products:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; 640-C Drywall Furring System.
 - c. USG Interiors, Inc.; Drywall Suspension System.
 - d. Provide comparable system where fire-rated ceilings are indicated.

2.4 STEEL PARTITION AND SOFFIT FRAMING

- A. Manufacturers:
1. Clark Dietrich Building Systems; ProSTUD 20.
 2. Marino\Ware; ViperStud 20.
 3. Super Stud Building Products, Inc.; The Edge Super 20.

- B. Gauge Equivalent Drywall Framing, Steel Studs and Runners: ASTM C 645.
 - 1. Minimum Base Metal Thickness: For all studs locations, 0.0200 inch (20 gage equivalent studs) minimum.
 - 2. Depth: As indicated.
 - 3. Maximum Allowable Deflection: Increase metal thickness where required to meet the following:
 - a. Maximum Allowable Deflection for Drywall Assemblies: $L/240$ calculated using a 5 pound per square uniform load perpendicular to studs and based on stud properties alone.
 - b. Maximum Allowable Deflection for Tile Backing Panels: $L/360$ calculated using a 5 pound per square uniform load perpendicular to studs and based on stud properties alone.
- C. Deep-Leg Deflection Track: ASTM C 645 top runner with flanges to allow for 3/4-inch deflection at floors and 1-1/2 inch at roof/ceiling assemblies.
- D. Firestop Deflection Track: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs. Provide deflection track with flanges to allow for 3/4-inch deflection at floors and 1-1/2 inch at roof/ceiling assemblies.
 - 1. Product: Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
- E. Radius Track: Factory fabricated runner track, providing smooth, non-segmented continuous one-piece shape.
 - 1. Product: Radius Track Corporation, (888) 872-3487.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base Metal Thickness: 0.0598 inch (16 gage), unless indicated otherwise.
- G. Cold-Rolled Channel Bridging: 0.0538-inch (16 gage) minimum bare steel thickness, with minimum 1/2-inch- wide flange.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch- thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 0.0312 inch (20 gage).
 - 2. Depth: 7/8 inch, unless otherwise indicated.
- I. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Asymmetrical.
- J. Furring Brackets: Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C 645, 20 gage, .0329 inch, designed for screw attachment to steel studs and steel rigid furring channels used for furring.
- K. Deflection Brackets:
 - 1. Construction: Slotted galvanized steel angle with step bushing to prevent over tightening of fasteners.

2. Vertical Deflection: 1-1/2 inch total travel.
3. Product: VertiClip; Signature Industries, (919) 844-0789.
 - a. Series: SL, SDL, SLB, and SLS as required by attachment condition.

- L. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.

2.5 PANELS, GENERAL

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Manufacturers:
 1. G-P Gypsum Corporation.
 2. National Gypsum Company.
 3. United States Gypsum Company.

2.6 INTERIOR GYPSUM WALLBOARD

- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
- B. Type X, GPDW:
 1. Thickness: 5/8 inch.
 2. Long Edges: Tapered.
 3. Location: All locations, except as otherwise noted.
- C. Moisture- and Mold-Resistant Type, GPDW-MMR: ASTM C 1396/C 1396M and ASTM C 630 with moisture- and mold-resistant core and surfaces.
 1. Core: 5/8 inch, Type X.
 2. Long Edges: Tapered.
 3. Mold-Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
 4. Face Sheets: 100 percent post-consumer recycled content.
 5. Location: Interior face of all exterior walls; walls and ceilings of toilet rooms and janitor closets, except as indicated otherwise; and where indicated.
 - a. In toilet rooms use tile backer board behind tile.
 6. Products:
 - a. G-P Gypsum Corp.; Toughrock Mold-Guard Gypsum Board.
 - b. National Gypsum Co.; Gold Bond Brand XP Gypsum Board.
 - c. United States Gypsum Co.; Mold Tough Interior Panels.
- D. Impact- and Penetration-Resistant Gypsum Wallboard: ASTM C 630 and C 1396, Type X; gypsum core wall panel with additives to enhance fire- and mold/mildew-resistance of core; surfaced with abrasion-, moisture-, and mold/mildew-resistant paper on the front, back and long edges; with a fiberglass mesh embedded in the board to enhance impact/penetration resistance.
 1. Products:
 - a. Hi-Impact Brand XP Fire-Shield Wallboard; National Gypsum Company.

- b. Fiberock Brand VHI Abuse-Resistant Gypsum Fiber Interior Panels; United States Gypsum Co.
- 2. Thickness: 5/8 inch.
- 3. Long Edges: Tapered.
- 4. Surface Abrasion Resistance: ASTM D 4977 (Modified), not greater than 0.284 inch depth when tested at 50 cycles.
- 5. Indentation Resistance: ASTM D 5420, not greater than 0.16 inch depth when tested at an impact load of 72 in.-lbs.
- 6. Impact/Penetration Resistance: ASTM E 695, not less than 480 ft.-lbs required to penetrate when using a weight of 60 lbs.
- 7. Mold/Mildew Resistance: ASTM D 3273, not less than 8.
- 8. Location: Assembly Hall 126.

2.7 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: Complying with ASTM C 1178/C 1178M.
 - 1. Products:
 - a. DensShield Tile Guard; G-P Gypsum Corporation.
 - b. National Gypsum Company; Gold Bond e²XP Tile Backer Panel.
 - 2. Core: 5/8 inch, Type X.
 - 3. Mold-Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
 - 4. Locations: Behind wall tile.

2.8 TRIM ACCESSORIES

- A. Interior Metal Trim: ASTM C 1047, galvanized steel.
 - 1. Shapes:
 - a. Cornerbead: 1-1/4 inch x 1-1/4 inch external corner with 1/8-inch nose bead. Use at outside corners, unless otherwise indicated.
 - b. LC-Bead (Casing): J-shaped casing with 1/16-inch nose bead ground, not less than 30 gage; exposed long flange receives joint compound; use at exposed panel edges.
 - c. Expansion (Control) Joint: One-piece control joint formed with V-shaped slot and removable strip covering slot opening.
- B. Interior PVC Trim: ASTM C 1047, PVC plastic.
 - 1. Shadow Mold with Tear Away Bead (Vinyl Trim with Tear Away Reveal): Z-shaped trim to create 1/2-inch wide reveal.
 - a. Manufacturer: Trim-Tex, Inc.

2.9 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper reinforcing tape. Fiberglass tape not permitted.
 - 2. Glass-Mat, Water-Resistant Tile Backing Panels: As recommended by panel manufacturer.

- C. Setting-Type Joint Compound: Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.
 - 1. Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.
- D. Drying-Type Joint Compound: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
 - 1. Ready-Mixed Formulation: Factory-mixed product.
- E. Type of Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound or drying-type, all-purpose compound.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.
- F. Joint Compound for Tile Backing Panels:
 - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by manufacturer.
 - a. Use setting type compound only for panels receiving tile finishes.

2.10 ACOUSTICAL SEALANT

- A. Products:
 - 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
 - b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.
 - 2. Acoustical Sealant for Concealed Joints:
 - a. Ohio Sealants, Inc.; Pro-Series SC-175 Acoustical Sound Sealant.
 - b. Pecora Corp.; AIS-919.
 - c. Tremco, Inc.; Tremco Acoustical Sealant.
- B. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- C. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

2.11 SEALANTS FOR FIRE-RESISTANCE-RATED CONSTRUCTION

- A. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Materials shall comply with Division 07 Section "Fire-Resistive Joint Systems" and submitted UL assemblies.
 - 1. Provide firestopping where fire rated gypsum board assemblies butt masonry, steel deck, joists, beams, and structural members as part of the gypsum board assembly work.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
 - 3. Joints shall be sealed with fire-resistance-rated sealants; use of joint compound for sealing of joints is not permitted.
- C. Exposed Fire-Resistive Joint Sealants: Exposed sealants shall be paintable.

2.12 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Fastening gypsum board to steel members: Type S bugle head.
 - 2. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
- C. Sound Attenuating Batts, SAB: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass that is fire resistance in accordance with ASTM E 136 and sound control in accordance with ASTM E 423; designed to reduce airborne sound transmission; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Thermal fiberglass insulation not allowed.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
 - 2. Sound Attenuating Batts in Wall Assemblies: Provide in thickness for full depth of cavity. Where cavity requires insulation that is thicker than standard size, install next larger size and compress into cavity.
 - a. STC Rating for Interior Walls: As indicated.
 - 3. Products:
 - a. Johns Manville; Fiberglass Sound Control Batts.
 - b. Knauf Insulation; Quiet Therm Acoustical/Thermal Batt Insulation.
 - c. Owens Corning; Sound Attenuation Batt Insulation.
- D. Thermal Insulation: As specified in Division 07 Section "Building Insulation."
- E. Insulation Support Anchors: Continuous, galvanized metal support strip, 25 gage, with pre-punched tabs at 8 inches on center.
 - 1. Product: Insul-hold; Insul-Hold Co., Inc.; phone (207) 465-9066.

- F. Firestopping: See Division 07 Sections "Penetration Firestopping" and "Fire-Resistive Joint Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Post-Installation Inspection: Inspect walls for dents and imperfections, with Installer and painter present, prior to painting. Verify exposed joints are finished up to required heights (to above acoustical ceilings and full height in rooms without ceilings). Inspect wall again after primer and first coat of paint applied, with Installer and painter present. Installer shall touch-up as follows:
 - 1. Touch-up visible gypsum board imperfections before priming of walls.
 - 2. Touch-up imperfections found in field of boards and joints made visible from painting after first finish coat applied.
 - 3. Joint compound touch-up shall be primed and painted and viewed for acceptability before final coat is applied.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

3.3 STEEL FRAMING INSTALLATION, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, laboratory casework, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."
- C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.
 - 1. Isolate ceiling assemblies where they abut or are penetrated by building structure.

2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
 - a. Allow for 3/4-inch deflection at floors and 1-1/2 inches at roof/ceiling assemblies.
 - b. Install deflection track top runner or deflection brackets to attain lateral support and avoid axial loading.
 - c. Install deflection firestop track top runner at fire-resistance-rated assemblies.
 - 1) Attach jamb studs at openings to tracks using manufacturer's standard stud clip.

3.4 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend ceiling hangers from building structure as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 3. Wire Hangers: Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 4. Do not attach hangers to steel roof deck.
 5. Do not attach hangers to permanent metal forms. Attach hangers to structural members.
 6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck. Attach hangers to structural members.
 7. Do not connect or suspend steel framing from ducts, pipes, or conduit. Attach hangers to structural members.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
- F. Sway-brace suspended steel framing with hangers used for support.
- G. Wire-tie furring channels to supports, as required to comply with requirements for assemblies indicated.

- H. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
 - 1. Hangers: 48 inches o.c.
 - 2. Carrying Channels (Main Runners): 48 inches o.c.
 - 3. Furring Channels (Furring Members): 16 inches o.c.
- I. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.5 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
 - 1. Cut studs 1/2 inch short of full height to provide perimeter relief. Do not fasten studs to top track to allow independent movement of studs and track.
 - 2. For fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
- D. Install steel studs and furring at the following spacings:
 - 1. Single-Layer Construction: 16 inches o.c., unless otherwise indicated.
 - 2. Multilayer Construction: 16 inches o.c., unless otherwise indicated.
- E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
 - 1. Attach both flanges to floor runner track with screws.
- F. Curved Partitions, Ceilings and Soffits:
 - 1. Cut top and bottom track (runners) through leg and web at 2-inch intervals for arc length. In cutting lengths of track, allow for uncut straight lengths of not less than 12 inches at ends of arcs.
 - 2. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - 3. Support outside (cut) leg of track by clinching steel sheet strip, 1-inch- high-by-thickness of track metal, to inside of cut legs using metal lock fasteners.
 - 4. Begin and end each arc with a stud, and space intermediate studs equally along arcs at stud spacing recommended in writing by gypsum board manufacturer for radii indicated. Attach studs to bottom runners with 3/8-inch- long pan head framing screws into both flanges. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches o.c.

5. Premanufactured Runner Option: Provide pre-manufactured radius runners to uniform curve of radius indicated and locate straight lengths so they are tangent to arcs.
- G. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
1. Install two studs at each jamb, unless otherwise indicated.
 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint.
 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above, even when partitions are not full height. Provide diagonal bracing at tall partitions to stop deflection and vibration of studs when doors are slammed shut.
 4. Extend jamb studs one-piece full height.
- H. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- I. Installation Tolerance: Framing members shall be within the following limits:
1. Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing, a total variation of 1/4 inch in 8 feet from a true plane.
 2. Layout of Walls and Partitions: 1/4 inch from intended position.
 3. Plates and Runners: 1/4 inch in 10 feet from a straight line.
 4. Studs: 1/4 inch in 10 feet out of plumb, not cumulative.
 5. Headers and Sills of Openings: 1/8 inch from level across width of opening.
 6. Soffits: 1/4 inch in 10 feet from level straight line.
 7. Spacing of Framing Members: Comply with requirements of ASTM C 754.
- J. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure. Install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
1. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - a. Fire-resistance rated joint designs shall maintain integrity throughout repetitive deflection cycles.

3.6 INSTALLATION OF SOUND ATTENUATING BATTS

- A. Install sound attenuating batts at locations indicated before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections that interfere with placement. Install insulation in voids as framing is installed that that would be inaccessible after completion of framing.
- B. Install a single layer of batts of required thickness to fill the full depth of cavity, unless otherwise shown. Where cavity requires batt that is thicker than standard size, install next larger size and compress into cavity.

- C. Hold sound attenuating batts in place with insulation support anchors located at 5 feet on center full height of wall, starting at the top of each stud space.
- D. Stuff glass fiber loose fill insulation into miscellaneous voids and cavity spaces. Fill box headers, and voids while framing is being erected that will be inaccessible for installation later. Compact to approximately 40 percent of normal maximum volume (to a density of approximately 2.5 pcf).

3.7 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216, except as specified otherwise.
- B. Install acoustical insulation, where indicated, before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attachment to Steel Framing: Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Form control and expansion joints with space between edges of adjoining gypsum panels.
 - 1. Where control joints are not shown, provide control joints at a maximum spacing of 30 feet; review proposed locations with Architect prior to commencement of work.
- I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect beams, joists and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by beams, joists, and other structural members; allow 1/4- to 3/8-inch- wide joints to install sealant. Caulk smoke partitions with acoustical sealant on both sides of wall to prevent the passage of smoke. Run board to within 1/4 inch of floor slabs to provide full support of resilient base.
- J. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with casing bead

edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

1. Use fire-rated acoustical sealant for fire-rated walls.
- K. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
1. Space screws a maximum of 12 inches o.c. for vertical applications.
- L. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.
- M. Remove screws that do not hit studs, supports, or blocking.

3.8 PANEL APPLICATION METHODS

- A. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- B. Multilayer Application on Ceilings: Apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
- C. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
- D. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- E. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- F. Curved Partitions, Ceilings and Soffits:
1. Install panels horizontally (perpendicular to supports) and unbroken, to the extent possible, across curved surface plus 12-inch-long straight sections at ends of curves and tangent to them.
 2. Wet gypsum panels on surfaces that will become compressed where curve radius prevents using dry panels. Comply with gypsum board manufacturer's written recommendations for curve radii, wetting methods, stacking panels after wetting, and other preparations that precede installing wetted gypsum panels.
 3. On convex sides of partitions, begin installation at one end of curved surface and fasten gypsum panels to studs as they are wrapped around curve. On concave side, start

fastening panels to stud at center of curve and work outward to panel ends. Fasten panels to framing with screws spaced 12 inches o.c.

4. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.
5. Allow wetted gypsum panels to dry before applying joint treatment.

G. Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.
2. Where tile backing panels abut other types of panels in the same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.9 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Install corner bead at external corners.
- C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.
 1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
 2. Install L-bead where edge trim can only be installed after gypsum panels are installed.
 3. Install U-bead where indicated.
 4. Install shadow molding where indicated.
 5. Curved-Edge Cornerbead: Use at curved openings.
- D. Control Joints: Install control joints according to ASTM C 840 and, prior to commencement of work, in specific locations approved by Architect for visual effect.

3.10 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, flanges of corner bead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, beveled edges, and damaged surface areas using setting-type joint compound.
- C. Apply joint tape over gypsum board joints and to flanges of trim accessories, except those with trim having flanges not intended for tape.

- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
1. Level 1: At ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 2. Level 2: At ceiling plenum areas, concealed areas, and where indicated, for fire-resistance-rated assemblies, and smoke assemblies.
 3. Level 2: Where panels are substrate for tile and where indicated.
 4. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
 5. Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over entire surface where indicated.
 - a. Location: Provide on walls of areas defined by Column Lines 5 to 6 and Z and B on all levels.
- E. Glass-Mat, Water-Resistant Backing Panels: Finish board forming base for ceramic tile to comply with ASTM C 840 and according to manufacturer's written instructions for treatment of joints behind tile.
- F. Where Level 1 gypsum board finish is indicated, embed tape in joint compound. Surface shall be free of excess joint compound.
- G. Where Level 2 gypsum board finish is indicated, fill fastener heads, embed tape in joint compound and apply thin coat of joint compound over all joints and interior angles.
- H. For Level 4 gypsum board finish, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration.
1. At tapered edge joints, draw compound down to a level plane, leaving a monolithic surface that is flush with paper face. Finish coat shall be feathered a minimum of 8 inches beyond both sides of center of joint tape.
 2. At end-to-end butt joints, draw compound down to minimize hump created by joint tape application. Finish coat shall be feathered a minimum of 16 inches beyond both sides of center of joint tape.
 3. End product shall be a surface that appears level without telegraphing joint locations as high spots when viewed down wall after painting.
 4. Finish board to within 1/4 inch of floor, providing full support for resilient wall base without telegraphing joint.
- I. Where Level 5 gypsum board finish is indicated, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories as specified above for Level 4; and apply a thin, uniform skim coat of joint compound over entire surface. For skim coat, use joint compound specified for third coat, or a product specially formulated for this purpose and acceptable to gypsum board manufacturer. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects, tool marks, and ridges and ready for decoration.
1. Location: Provide on walls of areas defined by Column Lines 5 to 6 and Column Lines Z to B on all levels.

3.11 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
 - 1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 - 2. Before notifying Architect, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air-duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control-air tubing.
 - f. Installation of above ceiling automatic fire suppression piping, including leak and pressure testing.
 - g. Installation of ceiling support framing.

3.12 CLEANING

- A. Promptly remove any residual joint compound from adjacent surfaces.

3.13 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092950

SECTION 093100 - TILE

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. Ceramic wall tile.
 - 2. Paver tile (porcelain tile).
 - 3. Waterproof membrane for tile installations.
 - 4. Crack-suppression membrane for thin-set tile installations.
 - 5. Metal edge strips installed as part of tile installations.
 - 6. Manufactured control joints installed as part of tile installations.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-In-Place Concrete" for monolithic slab finishes specified for tile substrates.
 - 2. Division 09 Section "Gypsum Board Assemblies" for glass-mat, water-resistant backer board.
 - 3. Division 22 Sections for floor drains installed in tile floors.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- D. Samples for Initial Selection: For each type of stone threshold and grout indicated consisting of actual products showing full range of colors available. Include Samples of accessories involving color selection.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
 - 1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.

- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
 - 1. Stone thresholds.
 - 2. Waterproofing.
 - 3. Crack-suppression membrane.
 - 4. Manufactured control joints.
 - 5. Metal edge strips.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Assemble all trades working at Project site to coordinate the work and to prevent workers from walking on newly installed tiles for required setting bed and grout cure times. Large tile will require additional time for the mortar bed to cure. Contractor to coordinate project schedule to complete work by other trades and vacate areas receiving floor coverings, stopping pedestrian traffic over newly installed flooring installation until curing and drying period is complete. Contractor shall conduct periodic coordination meetings with all trades to review schedule and procedures to prevent interference and damage during installation and curing and drying periods of floor coverings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
 - 1. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient and substrate temperatures and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.
 - 1. Maintain temperatures at 50 deg F or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.
- B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.3 TILE PRODUCTS

- A. Unglazed Paver Tile (Porcelain Tile)PT1thru PT4: Flat tile as follows:
 - 1. Manufacturer: Daltile
 - 2. Product: Diamante Colorbody Porcelain Tile
 - 3. Composition: Porcelain.
 - 4. Face Size:
 - a. 12 inches by 24 inches.
 - 5. Thickness: 3/8 inch.
 - 6. Face: Plain with square edges.
 - 7. Finish: Unpolished.
 - 8. Trim Units, PT5: Cove base, 6 inches by 12 inches.
 - 9. Products: As indicated on Materials Legend.
 - a. Colors: As indicated on Materials Legend.
- B. Ceramic Wall Tile, CT1 : Flat tile as follows:
 - 1. Manufacturer: Daltile
 - 2. Product: Rittenhouse Square
 - 3. Module Size: 3"x6".
 - 4. Thickness: 5/16 inch.
 - 5. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base for Thin-Set Mortar Installations: Straight.

- b. Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, 3"x6" module size with manufactured outside corners.
- c. External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.
- d. Internal Corners: Field-buttet square corners.

2.4 WATERPROOF MEMBRANE FOR THIN-SET TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
 - 1. Products:
 - a. LATICRETE International Inc.; Laticrete 9235 Waterproof Membrane.
 - b. MAPEI Corporation; Mapelastic AquaDefense.

2.5 CRACK ISOLATION MEMBRANE FOR THIN-SET TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of a two-part, liquid rubber and fabric reinforcement.
 - 1. Locations: Use under porcelain paver tiles at all cracks and control joints.
 - 2. Products:
 - a. Laticrete International, Inc.; Laticrete Blue 92 Anti-Fracture Membrane.
 - b. MAPEI Corporation; Mapelastic AquaDefense.

2.6 SETTING AND GROUTING MATERIALS

- A. Latex-Portland Cement Mortar for Large Format Tile (Medium Set) and Grout: ANSI A118.4 and ANSI A118.6 respectively. Provide product that is approved by manufacturer for application thickness of up to 3/4 inch without shrinkage for tile larger than 12- by 12-inches.
 - 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - a. For wall applications, provide mortar that complies with Paragraph F-4.6.1 in addition to the requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
 - b. Products:
 - 1) Bostik; StoneWall High Performance & Non-Sag Mortar.
 - 2) LATICRETE; Laticrete 255 MultiMax.
 - 3) MAPEI; Ultraflex LFT.
 - 4) TEC Specialty Products; 3N1 Performance Mortar.
 - 2. Grout Colors: As indicated on Materials Legend; in locations not indicated, as selected by Architect from manufacturer's full range of colors.

2.7 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips at Tile: Stainless steel, L-shaped profile, 1/8-inch wide at top edge with integral provision for anchorage to mortar bed or substrate and integrated grout joint spacer.
 - 1. Finish: As selected by Architect.
 - 2. Height: For 3/8-inch thick tile.
 - 3. Locations: Provide at the following locations and where indicated:
 - a. Tile to carpet transitions.
 - b. Outside corners for wall tile.
 - c. Wainscot cap for wall tile.
 - 4. Product: Schluter Systems; Schluter-SCHIENE.
- C. Metal Transition Strips at Tile to Resilient Flooring Transitions: Stainless steel transition strip, brushed finish, ADA compliant, for transitioning from tile to lower profile floor covering; transition strip shall have integral provision for anchorage to mortar bed.
 - 1. Product: Schluter Systems; Reno-U-E.
- D. Control Joints (CJ): Control joints for porcelain tile, thermoplastic movement joint with opposing stainless steel profiles, brushed finish. Color of thermoplastic movement material as selected by Architect from manufacturer's full range of options.
 - 1. Product: Schluter Systems; Schluter DILEX-KSN.
- E. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- F. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints that does not change color or appearance of grout.
 - 1. Products:
 - a. Bostik, Inc.; CeramaSeal Grout & Tile Sealer.
 - b. MAPEI Corporation; KER 004, Keraseal Penetrating Sealer for Unglazed Grout and Tile.
 - c. TEC; a subsidiary of H. B. Fuller Company; TA-256 Penetrating Silicone Grout Sealer.

2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions, including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.
- B. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
1. Check flatness of substrate by laser. Level floor to provide a base for medium set that allows for a smooth, flat floor without irregularities. Verify proper drainage to drains. Grinding high spots until substrate is acceptable to the flooring Installer is specified in Division 03 Section "Cast-in-Place Concrete."
 2. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
 3. Verify that concrete substrates for tile floors installed with medium-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 4. Verify that gypsum board substrates for wall tile comply with the surface finish requirements in ANSI A108.01 for installations indicated and the following:
 - a. Flatness shall not vary more than 1/4-inch in 10 feet.
 - b. Verify that substrate is properly supported in corners.
 - c. Verify that fasteners are properly spaced and covered.
 - d. Verify that joint treatment is fully cured.
 5. Verify that installation of anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with medium-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Lay tile in patterns indicated. When field conditions conflict with indicated pattern, notify Architect in writing prior to installation for review and approval of revisions.
 - 1. Where tile patterns require cutting of tile, do not install tile with chipped or cracked edges.
- D. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- F. Tile shall lay flat and each edge flush with adjacent tile, free of tilting and skewed tile. Provide additional setting material to shim accent tiles that are thinner than field tiles so face is in same plane.
- G. Jointing Pattern: Lay tile in pattern indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area, unless indicated otherwise. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- H. Lay out tile wainscots to next full tile beyond dimensions indicated.
- I. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Locate expansion joints where indicated; if not indicated, in accordance with approved Shop Drawings, the TCNA Handbook and as follows:
 - a. For slabs on grade, space joints no greater than 20- to 25-feet apart in each direction, except as noted otherwise.
 - 1) For slabs on grade exposed to direct sunlight or moisture, space joints no greater than 8- to 12-feet apart in each direction.
 - b. For elevated slabs, space joints no greater than 8- to 12-feet apart in each direction.
- J. Grout tile to comply with requirements of the following tile installation standards:
 - 1. For ceramic tile grouts (latex-portland cement grouts), comply with ANSI A108.10.

3.4 WATERPROOFING AND CRACK-SUPPRESSION MEMBRANE INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.
 - 1. Install continuous fabric reinforcement over entire floor.
 - 2. Turn membrane with fabric reinforcement up walls as follows to keep water from traveling under partitions:
 - a. Toilet and Shower Rooms with Tile Floors: 2 inches minimum at perimeter walls of rooms.
- B. Install crack-suppression membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate.
 - 1. Install fabric reinforcement in crack-suppression membrane at all cracks, saw cuts and room perimeter sealing.
- C. Do not install tile over waterproofing system and crack-suppression system until systems have cured and waterproofing system has been tested to determine that it is watertight.

3.5 FLOOR TILE INSTALLATION

- A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.
 - 1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
 - a. Tile floors composed of tiles 8 by 8 inches or larger.
- B. Joint Widths: Install tile on floors with the following joint widths:
 - 1. Paver Tile (Porcelain Tile): 1/8 inch.
- C. Metal Edge Strips: Install each type of transition strip at locations appropriate to edge type.
- D. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.6 WALL TILE INSTALLATION

- A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
- B. Joint Widths: Install tile on walls with the following joint widths:
 - 1. Paver Tile (Porcelain Tile): 1/8 inch.
 - 2. Ceramic Wall Tile: 1/16 inch.

3.7 CLEANING AND PROTECTING

- A. Remove and replace material that is stained or otherwise damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove latex-portland cement grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
- C. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- D. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- E. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.8 TILE INSTALLATION SCHEDULE

- A. Paver Tile (Porcelain Tile) Floor Tile over Concrete Floor on Grade: Medium-set latex portland cement mortar tile setting bed over crack-suppression membrane applied to saw cuts and random cracks, TCA F125. Apply joint sealer to tile joints.
 - 1. At Toilet and Shower Rooms, seal perimeter of room by running waterproof membrane with reinforcing fabric up wall 2 inches minimum.
- B. Ceramic and Porcelain Wall Tile on Glass-Mat, Water Resistant Backer Board: Latex portland cement mortar tile setting bed, TCA W245.

END OF SECTION 093100

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SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Acoustical panels.
 - 2. Exposed suspension systems.
- B. Related Sections include the following:
 - 1. Division 06 Section "Finish Carpentry" for cementitious, acoustical ceiling panels.
 - 2. Division 09 Section "Gypsum Board Assemblies" for suspension systems provided for gypsum board ceilings.
 - 3. Division 21, 22, 23, 26, and 27 Sections for coordination of air handling devices, fire protection devices, and electrical devices installed in ceiling systems.

1.3 DEFINITIONS

- A. CAC: Ceiling Attenuation Class.
- B. NRC: Noise Reduction Coefficient.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
 - 2. Suspension System: Obtain all suspension systems through one source from a single manufacturer.

- B. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
 - 1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
 - a. Smoke-Developed Index: 450 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes. Store materials flat.
- B. Before installing acoustical panels permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Mechanical, electrical, and other utility service installations above the ceiling plane shall have been completed prior to the installation of the ceilings.

1.8 COORDINATION

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

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed, but not less than 4 full cartons of tile ACT 1 and 1 full cartons of tile ACT 2.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Recycled Content: Provide acoustical panels with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 35 percent by weight.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.
 2. Test Method for Ceiling Attenuation Class (CAC). Where acoustical panel ceilings are specified to have a CAC, provide units identical to those tested per ASTM E 1414 by a qualified testing agency.
- C. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
- D. Coating-Based Antimicrobial Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273.

2.3 ACOUSTIC PANELS

- A. Acoustic Panel: ACT-1.
1. Size: 24 inches x 24 inches.
 2. Thickness: Not less than 3/4-inch thick.
 3. Composition: Mineral wool fiber.
 4. Surface Finish: Factory-applied latex paint; white.
 5. Surface Texture: Medium texture.
 6. Edge: Angled tegular.
 7. NRC Range: Not less than 0.70.
 8. CAC Range: 35.
 9. Fire Hazard Classification: Class A, 0 - 25 flame spread.
 10. Dimensional Stability: Sag resistant at high humidity.

11. Antimicrobial Treatment: Coating based, front and back.
 12. Products:
 - a. Armstrong World Industries, Inc.; Fine Fissured No. 1756.
 - b. USG Interiors, Inc.; Radar ClimaPlus High NRC No. 22121.
 - c. CertainTeed Ceilings; Fine Fissured High NRC No. HHF-454 DP.
 13. Suspension System Type: A.
- B. Acoustic Panel: ACT-2.
1. Size: 24 inches x 48 inches.
 2. Thickness: Not less than 1/2- inch thick.
 3. Composition: Mineral wool fiber.
 4. Surface Finish: High-density, ceramic- and mineral-base panels with scrubbable finish.
 5. Edge: Square.
 6. CAC Range: 35 - 40.
 7. Fire Hazard Classification: Class A, 0 - 25 flame spread.
 8. Dimensional Stability: Sag resistant at high humidity.
 9. Products:
 - a. Armstrong World Industries, Inc.; Ceramaguard Unperforated No. 605.
 - b. USG Interiors, Inc.; Clean Room ClimaPlus Class 100 Panels, No. 56099.
 - c. CertainTeed Ceilings; Vinylrock X, No. 1142-CRF-1.
 10. Suspension System Type: B.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
 1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.
 1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 1. Zinc-Coated Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.

- E. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.
 - 1. Locations:
 - a. In Vestibules and for a distance of 10 feet inside exterior doors without Vestibules.
 - b. Where indicated.

2.5 METAL SUSPENSION SYSTEMS FOR ACOUSTICAL PANEL CEILINGS

- A. Type A: Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with prefinished 15/16-inch- wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Runners: Override (stepped) or butt-edge type, as standard with manufacturer.
 - 3. Face Design: Flat, flush.
 - 4. Cap Material: Steel or aluminum cold-rolled sheet, as standard with manufacturer.
 - 5. Cap Finish: Painted white.
 - 6. Locations: For all suspended acoustical ceilings, except as otherwise noted.
 - 7. Products:
 - a. Armstrong World Industries, Inc.; Prelude XL Exposed Tee System, 7300 Series.
 - b. Chicago Metallic Corporation; 1200 System.
 - c. USG Interiors, Inc.; DX System.
- B. Type B: Wide-Face, Aluminum Capped, Double-Web, Hot-Dip Galvanized, G60, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A 653/A 653M, G60 coating designation, with prefinished, cold-rolled, 15/16-inch- wide, aluminum caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. Face Design: Flat, flush.
 - 3. Face Finish: Painted white.
 - 4. Locations: For use with ACT-2.
 - 5. Products:
 - a. Armstrong World Industries, Inc.; Prelude XL, 7301WA Series.
 - b. Chicago Metallic Corporation; Fire Front 1830 System.
 - c. USG Interiors, Inc.; ZXLA System.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION, GENERAL

- A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Hangers shall be single lengths of wire without splices; coordinate lengths in deep ceiling cavities.
 - 2. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 3. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 4. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - 5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 7. Do not attach hangers to steel deck tabs.
 - 8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 9. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 - 10. Exposed pop rivets for grid alignment purposes shall not be permitted.
- C. Suspension system shall be reinforced to support diffusers, light fixtures and any additional members. Install hanger wires to grid at each corner of light fixtures. Coordinate location with electrical and other trades.
 - 1. Each individual fixture and attachment with combined weight of 56 pounds or less shall have two 12-gage wire hangers attached at diagonal corners of the fixture. These wires shall be slack. Fixtures and attachments with a combined weight of greater than 56 pounds shall be independently supported from the structure at all four corners.

- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels to run in the same direction.
 - 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 - 3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 - 5. Install hold-down clips in Vestibules and at areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.

3.4 CLEANING

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

END OF SECTION 095113

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SECTION 096500 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sheet linoleum floor covering, with jute backing.
 - 2. Resilient base.
 - 3. Resilient stair accessories.
 - 4. Resilient molding accessories.
 - 5. Independent testing of concrete.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For each type of resilient flooring. Include resilient flooring layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, cutouts, and the following:
 - 1. Show locations of seams for sheet floor coverings.
- D. Samples for Initial Selection: For each type of product indicated.
 - 1. Welding Bead: Actual strips of welding bead, manufacturer's standard size, showing full range of colors available.
 - 2. Resilient Accessories: Actual pieces of strips of resilient base showing full range of colors available for each product exposed to view.
 - 3. Tread Insert: Actual pieces of tread inserts showing full range of colors available.
- E. Seam Samples: For seamless-installation technique indicated and for each flooring product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch Sample applied to a rigid backing and prepared by Installer for this Project.
- F. Product Schedule: For flooring products. Use same designations indicated on Drawings.
- G. Qualification Data: For qualified Installer.
- H. Test Results: Submit results of specified alkalinity and adhesion tests, calcium chloride moisture tests, and relative humidity tests specified. Include manufacturer's written moisture requirements for each resilient flooring type specified.
- I. Maintenance Data: For each type of flooring product to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for resilient flooring installation and seaming method indicated.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver resilient flooring materials and installation accessories to Project site in original manufacturer's unopened cartons and containers each bearing name of product and manufacturer, Project identification, and shipping and handling instructions.
- B. Store resilient flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces and rolls upright.

1.6 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive resilient flooring during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. Do not install flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive as determined by manufacturer's recommended bond and moisture test.
- C. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- D. Close spaces to traffic during resilient flooring installation and for 48 hours after installation.
- E. Install resilient flooring after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sheet Floor Covering: Furnish quantity not less than 10 linear feet for every 500 linear feet or fraction thereof, in roll form and in full roll width for each color, pattern, and type of floor covering installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Products: Subject to compliance with requirements, provide one of the products specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 RESILIENT LINOLEUM SHEET FLOOR COVERING

- A. Resilient Sheet Floor Covering, LS, LS2, LS3, LS4.
1. Product: Forbo; Marmoleum.
 2. Thickness: 1/10 inch .
 3. Wearing Surface: Smooth.
 4. Sheet Width: 79 inches.
 5. Backing: Jute
 6. Seaming Method: Heat welded.
 7. Topshield 2 Finish: Applied during the manufacturing process.
 8. Colors and Patterns: As indicated by manufacturer's designations shown in Materials Legend.

2.3 RESILIENT WALL BASE

- A. Resilient Base, RWB1: ASTM F 1861.
1. Manufacturer: Johnsonite.
 2. Material Requirement: Type TP (rubber, thermoplastic).
 3. Manufacturing Method: Group I (solid, homogeneous).
 4. Style: Cove (base with toe).
 5. Minimum Thickness: 0.125 inch.
 6. Height: 6 inches.
 7. Lengths: Coils in manufacturer's standard length.
 8. Outside Corners: Job formed.
 9. Inside Corners: Job formed.
 10. Color: As indicated by manufacturer's designations shown in Materials Legend.
- B. Resilient Molding Accessory:
1. Manufacturers:
 - a. Johnsonite.
- C. Transition Strips: The following product identification numbers are for products manufactured by Johnsonite. Provide listed products or equal from one of listed manufacturers.
1. Carpet to Linoleum: No. CTA-XX-D.
 2. Linoleum to Concrete: No. RRS-XX-C.
 3. Carpet to Concrete: No. EG-XX-G.

- D. Step Nosing for Carpet, RN: Solid Color Flexible Vinyl Stair Nosings
 - 1. Product: Johnsonite; Vinyl Stair Nosings No. SVCD-XXX-A or equal from one of listed manufacturers.
- E. Colors and Patterns: As selected by Architect from manufacturer's full range of colors.

2.4 INSTALLATION MATERIALS

- A. Concrete Slab Primer: Nonstaining type as recommended by flooring manufacturer.
- B. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
 - 1. Product: Ardex; SD-F Feather Finish.
- C. Adhesives, General: Premium grade, water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.
 - 1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Linoleum Sheet Floor Coverings: Not more than 50 g/L.
 - b. Cove Base Adhesives: Not more than 50 g/L.
 - c. Rubber Stair Accessories: Not more than 60 g/L.
- D. Adhesive for Resilient Sheet Floor Covering: Water-resistant, solvent free, acrylic-polymer adhesive; product shall be suitable over new concrete substrates with in-situ moisture measurements of 80 percent RH as measured by ASTM F 2170.
 - 1. Product: Forbo; L 885 Adhesive.
- E. Seamless-Installation Accessories:
 - 1. Heat-Welding Bead: Manufacturer's net fit seams product for heat welding seams.
 - a. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

- B. Concrete Substrates: ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by the flooring manufacturers and with the following specified requirements:
 - 2. An independent testing agency shall perform alkalinity and adhesion tests, calcium chloride moisture tests, and relative humidity test. Field technician shall be International Concrete Repair Institute (ICRI) certified to a Grade 1, Moisture Testing Technician level. Testing shall be conducted as follows:
 - a. Maintain a minimum temperature of 70 deg F in spaces to receive flooring for at least 72 hours prior to and during the tests.
 - b. Perform the tests at rate of not less than 1 test/1000 sq. ft. of floor area.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 4. Moisture Testing: Perform tests recommended by manufacturer and as follows.
 - a. Anhydrous Calcium Chloride Test: Perform test in accordance with ASTM F 1869, except area of CaCl² dish shall not be deducted.
 - b. Relative Humidity Test: Perform test using in situ probes, ASTM F 2170.
 - c. 80 percent of the moisture tests conducted shall be relative humidity tests.
 - 5. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft. in 24 hours, a maximum 80 percent relative humidity level measurement, or greater if permitted by the flooring manufacturer, and manufacturer's requirements for alkalinity and adhesion are met.
- C. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- E. Do not install resilient flooring until it is same temperature as space where it is to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 RESILIENT FLOORING INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's written instructions and requirements of this Section.
- B. Scribe, cut, and fit flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.
- C. Extend flooring into toe spaces, door reveals, closets, and similar openings. Extend flooring to center of door openings.

- D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor covering as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

3.4 INSTALLATION OF SHEET FLOOR COVERING

- A. Comply with manufacturer's written instructions for installing floor coverings, including those for trowel notching, adhesive mixing, and adhesive open and working times.
 - 1. Areas exposed to direct sunlight shall be protected during conditioning, installation and adhesive curing periods by covering the light source.
 - 2. Do not use permanent or non-permanent markers, pens, crayons or paint to write on back of flooring material or to mark the substrate as they could bleed through and stain flooring material.
- B. Unroll floor coverings and allow them to stabilize before cutting and fitting.
- C. Lay out floor coverings as follows:
 - 1. Maintain uniformity of floor covering direction.
 - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in floor covering substrates.
 - 3. Match edges of floor coverings for color shading and pattern at seams.
 - 4. Avoid cross seams, except where indicated.
- D. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- E. Seamless Installation:
 - 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces. Wait a minimum of 24 hours after installation before heat welding seams.
- F. Roll sheet floor coverings in both directions from center out to embed floor coverings in adhesive and eliminate trapped air. At walls, door casings, and other locations where access by roller is impractical, press floor coverings firmly in place with flat-bladed instrument.

3.5 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required. Provide on fronts and exposed sides and backs of floor-mounted casework. Where toe space is less than base height, cut down base to proper height.
- C. Install base before installation of carpet.
- D. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

- E. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- F. Do not stretch resilient base during installation.
- G. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible. Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.
 - 3. Adhere base to substrate with contact adhesive 12 inches each side of outside corner to properly hold base in permanent proper position in tight contact with wall. Base shall run continuous around corners with butt joints 12 inches minimum for corner.

3.6 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Stair Accessories:
 - 1. Clean backs of tread and lightly sand to ensure proper adhesion.
 - 2. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - 3. Install treads with epoxy adhesive and roll until a firm bond has been obtained.
 - 4. Tightly adhere to substrates throughout length of each piece.
 - 5. For treads installed as separate, equal-length units, install to produce a flush joint between units.
- C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet and resilient floor coverings that would otherwise be exposed.
 - 1. Step nosing for carpeted risers shall have mitered corners.

3.7 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient floorings and accessories.
- B. Perform the following operations immediately after completing flooring installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces using cleaner recommended by resilient floor covering manufacturers.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
 - a. Do not wash surfaces until after time period recommended by manufacturer.

- C. Protect flooring products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.
- D. Final cleaning and buffing specified in Division 01 Section "Closeout Procedures."
- E. Cover resilient flooring with undyed, untreated building paper until Substantial Completion.
 - 1. Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 096500

SECTION 096800 - CARPET

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. Carpet tile.
 - 2. Broadloom carpet.
 - 3. Walk-off Mat.
 - 4. Independent testing of concrete.
- B. Related Sections include the following:
 - 1. Division 09 Section "Resilient Flooring" for resilient wall base and accessories installed with carpet.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For the following, including installation recommendations for each type of substrate:
- C. Shop Drawings: Show the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
 - 2. Carpet type, color, and dye lot.
 - 3. Carpet tile type, color, and dye lot.
 - 4. Seam locations, types, and methods.
 - 5. Type of subfloor.
 - 6. Type of installation.
 - 7. Pattern type, repeat size, location, direction, and starting point.
 - 8. Pile direction.
 - 9. Type, color, and location of insets and borders.
 - 10. Type, color, and location of edge, transition, and other accessory strips.
 - 11. Transition details to other flooring materials.
- D. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet: 12-inch- square Sample.
 - 2. Carpet Tile: Full size sample.
 - 3. Carpet Seam: 6-inch Sample.

- E. Product Schedule: For carpet and carpet tile. Use same room and product designations indicated on Drawings.
- F. Test Results: Provide results of specified alkalinity and adhesion tests, calcium chloride moisture tests, and relative humidity tests. Include manufacturer's written moisture requirements for each carpet type specified.
 - 1. New Concrete Slabs: Provide results of adhesive bond tests for all adhesive products used.
- G. Adhesive Certificates: Carpet and carpet tile manufacturers shall certify that proposed adhesives are acceptable for use with carpet and carpet tile.
- H. Maintenance Data: For carpet and carpet tile to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet and carpet tile.
- I. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Source Limitations: Obtain each type of carpet and carpet tile through a single source from a single manufacturer.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review specified moisture test results, alkalinity and adhesion tests, ambient conditions, ventilation procedures, installation process, adhesive application, seam sealing procedures and seam layouts. Compare results with manufacture's specified requirements for each product.

1.5 LAYOUT

- A. Seam Layout: Layout differing from approved Shop Drawings that is unacceptable to the Architect and Owner shall be sufficient reason for rejection.
- B. Install carpet in a manner that minimizes the number of seams that are perpendicular to traffic flow. Carpet grain and seams shall not run perpendicular to traffic flow in corridors.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with CRI's Carpet Installation Standard 2011, Section 5, "Storage and Handling."
- B. Deliver materials to Project site in original factory wrappings and containers, labeled with identification of manufacturer, brand name, and lot number.

- C. Store materials on-site in original undamaged packages, inside well-ventilated area protected from weather, moisture, soilage, extreme temperatures, and humidity. Lay flat, with continuous blocking off floor.

1.7 PROJECT CONDITIONS

- A. Comply with CRI's Carpet Installation Standard 2011, Section 7 "Site Conditions - All Installations" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not install carpet or carpet tile until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at and will be continuously maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet or carpet tile over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive, and concrete slabs have pH range recommended by carpet manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet or carpet tile, install carpet and carpet tile before installing these items.

1.8 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty for Carpet: Written warranty, signed by carpet cushion manufacturer agreeing to replace carpet that does not comply with requirements or that fails within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet due to failure of substrate, vandalism, or abuse. Warranty shall not require use of chair pads.
 - 2. Failures include, but are not limited to, surface wear including more than 10 percent loss of face fiber, edge raveling, snags, loss of tuft bind strength, zippering, backing resiliency loss, and delamination.
 - 3. Warranty Period:
 - a. Carpet: Lifetime Limited Woven Wear Warranty.
 - b. Carpet Tile: Lifetime Limited Woven Wear Warranty.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet: Full-width rolls equal to 3 percent of amount installed for each type indicated, but not less than 10 sq. yd.
 - 2. Carpet Tile: Full-size units equal to 3 percent of amount installed for each type and color indicated, but not less than 10 sq. yd.

PART 2 - PRODUCTS

2.1 CARPET

- A. CPT1: Shall be Karastan, a division of Mohawk Group, Style: Fascinated KC173, in color indicated in Materials Legend. No seconds or imperfections shall be acceptable. Carpet shall meet the following minimum construction:

1. Construction: Tufted.
2. Surface Texture: Textured Patterned cut and loop.
3. Pile Fiber and Type: Colorstrand Nylon
4. Dye Method: Solution dyed/ Yarn dyed.
5. Finished Pile Thickness: 0.154 inch.
6. Face Weight: 32.0 oz./sq. yd.
7. Pattern Repeat: 18"
8. Backing System: Unibond Plus Bloc
9. Soil Release Protection: Sentry Plus.
10. Width: 12' width.

- B. CPT2: Shall be Karastan, a division of Mohawk Group, Style: Hypnotizing DC157, in color indicated in Materials Legend. No seconds or imperfections shall be acceptable. Carpet shall meet the following minimum construction:

1. Construction: Tufted.
2. Surface Texture: Textured Patterned cut and loop.
3. Pile Fiber and Type: Colorstrand Nylon
4. Dye Method: Solution dyed/ Yarn dyed.
5. Finished Pile Thickness: 0.160 inch.
6. Face Weight: 32.0 oz./sq. yd.
7. Pattern Repeat: 18"x20"
8. Backing System: Unibond Plus Bloc
9. Soil Release Protection: Sentry Plus.
10. Width: 12' width.

2.2 CARPET TILE

- A. CPT3: Shall be Shaw Contract Group, Natural Palatte Collection, Technique 5T022, in color indicated in Materials Legend. No seconds or imperfections shall be acceptable. Carpet Tile shall meet the following minimum construction:

1. Construction: Tufted.
2. Surface Texture: Multi-Level Patterned cut and loop .
3. Pile Fiber and Type: Eco Solutions Q Nylon
4. Dye Method: 65% Solution dyed/ 35% Yarn dyed.
5. Gauge: 1/12.
6. Stitches per Inch: 11.
7. Face Weight: 34.0 oz./sq. yd.
8. Pile Thickness: 0.162 inch.
9. Soil Protection: SSP shaw soil protection.
10. Backing System: Ecoworx Tile
11. Installation Method: As indicated.
12. Size: 24"x24" Tile

- B. CPT4: Shall be Shaw Contract Group, Natural Palatte Collection, Blend 5T025, in color indicated in Materials Legend. No seconds or imperfections shall be acceptable. Carpet Tile shall meet the following minimum construction:
1. Construction: Tufted.
 2. Surface Texture: Multi-Level Patterned cut and loop .
 3. Pile Fiber and Type: Eco Solutions Q Nylon
 4. Dye Method: 50% Solution dyed/ 50% Yarn dyed.
 5. Gauge: 1/12.
 6. Stitches per Inch: 11.
 7. Face Weight: 34.0 oz./sq. yd.
 8. Pile Thickness: 0.162 inch.
 9. Soil Protection: SSP shaw soil protection.
 10. Backing System: Ecoworx Tile
 11. Installation Method: As indicated.
 12. Size: 24"x24" Tile

2.3 WALK-OFF MAT

- A. MAT1: Shall be Mats Inc. Supreme Nop, rolled glue down entrance mat in color indicated in Materials Legend. No seconds or imperfections shall be acceptable. Carpet Tile shall meet the following minimum construction:
1. Pile Fiber and Type: Polypropylene Fibers
 2. Dye Method: Solution dyed.
 3. Face Weight: 42.8 oz./sq. yd.
 4. Pile height: 3/16 inch.
 5. Backing System: Eco Di elephant back high density rubber
 6. Installation Method: Glue down
 7. Size: 13'-2" roll.

2.4 INSTALLATION ACCESSORIES

- A. Concrete Slab Primer: Nonstaining type provided by or recommended by carpet and carpet tile manufacturers.
- B. Trowelable Leveling and Patching Compounds: Portland-cement-based formulation provided by or recommended by carpet and carpet tile manufacturers.
1. Product: Ardex; SD-F Feather Finish.
- C. Adhesive for Carpet: Low VOC, premium grade, water-resistant, mildew-resistant, nonstaining adhesive as recommended by manufacturer to suit products and subfloor conditions.
1. Maximum Allowable MVER: 5 lbs. as measured by ASTM F 1869.
 2. Maximum Allowable RH: 80 percent RH as measured by ASTM F 2170.
- D. Adhesive for Carpet Tile: Low VOC, premium grade, water-resistant, mildew-resistant, nonstaining adhesive as recommended by manufacturer to suit products and subfloor conditions.
1. Maximum Allowable MVER: 5 lbs. as measured by ASTM F 1869.
 2. Maximum Allowable RH: 80 percent RH as measured by ASTM F 2170.
- E. Seaming Cement: Adhesive product recommended by carpet manufacturer for sealing seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Verify that substrates and conditions are satisfactory for carpet installation and comply with requirements specified.
- B. Examine carpet for type, color, pattern, and potential defects.
- C. Concrete Slabs : Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet manufacturer, and with the following specified requirements:
 - a. An independent testing agency shall perform alkalinity and adhesion tests, calcium chloride moisture tests, and relative humidity test. Field technician shall be International Concrete Repair Institute (ICRI) certified to a Grade 1, Moisture Testing Technician level. Testing shall be conducted as follows:
 - 1) Perform tests on slabs to receive glue down carpet installation at rate of 1 test/1000 sq. ft. of floor area.
 - 2) Maintain a minimum temperature of 70 deg F in spaces to be tested for not less than 72 hours prior to and during tests.
 - 3) Perform tests on both new and existing slabs.
 - b. Alkalinity and Adhesion Testing: Shall result in pH range recommended by carpet manufacturer when subfloor is wetted with potable water and pHydriion paper is applied. Perform pH tests on concrete floors regardless of age or grade level.
 - c. Calcium Chloride Moisture Tests: Tests shall be conducted in accordance with ASTM F 1869-02, except that area of CaCl₂ dish shall not be deducted.
 - d. Relative Humidity Test: Perform test using in situ probes, ASTM F 2170.
 - e. 80 percent of the moisture tests conducted shall be relative humidity tests.
 - 2. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft. in 24 hours, a maximum 80 percent relative humidity level measurement, and manufacturer's requirements for alkalinity and adhesion are met.
 - 3. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet.
 - 4. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits of any kind.
- D. If conditions detrimental to work are encountered, prepare written report, signed by Installer, documenting unsatisfactory conditions and send to the Architect.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI's Carpet Installation Standard 2011, Section 7, "Site Conditions - All Installations" and with carpet and carpet tile manufacturer's written installation instructions for preparing.

- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, unless more stringent requirements are required by manufacturer's written instructions.
- C. Level subfloor within 1/4 inch in 10 feet, noncumulative, in all directions using product recommended by manufacturer. Sand or grind protrusions, bumps, and ridges.
 - 1. Use leveling and patching compounds to fill cracks, holes, and depressions in subfloor as recommended by carpet and carpet tile manufacturers.
- D. Remove coatings, including curing compounds, paint, joint compound, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet and carpet tile manufacturers.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet and carpet tile. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Concrete Subfloor Preparation: Apply concrete slab primer, according to manufacturer's directions to comply with surface prep and PH requirements, where recommended by carpet, carpet tile, and carpet adhesive manufacturers.

3.3 CARPET INSTALLATION

- A. Comply with CRI's Carpet Installation Standard 2011 and carpet manufacturer's written installation instructions for the following:
 - 1. Direct-Glue-Down Installation: Comply with CRI Section 13, "Direct Glue-Down Installation."
- B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
 - 1. Bevel adjoining border edges at seams with hand shears.
- C. Where demountable partitions or other items are indicated for installation on top of finished carpet, install carpet before installation of these items.
- D. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- E. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

- G. Install pattern parallel to walls and borders to comply with CRI's Carpet Installation Standard 2011, Section 19, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.

3.4 CARPET TILE INSTALLATION

- A. Comply with CRI's Carpet Installation Standard 2011, Section 18, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
 - 1. Where carpet tile is installed on risers, provide adhesive type recommended by manufacturer for secure installation on vertical surface.
- C. Maintain dye lot integrity. Do not mix dye lots in same area.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls.

3.5 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet and carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet and carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet and carpet tile surface.
 - 3. Vacuum carpet and carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet and carpet tile to comply with CRI's Carpet Installation Standard 2011, Section 20, "Protection of Indoor Installations."
- C. Protect carpet and carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet and carpet tile manufacturers and carpet adhesive manufacturer to ensure carpet and carpet tile are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 096800

SECTION 098413 - FIXED SOUND-ABSORPTIVE PANELS

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. Back-mounted acoustical wall panels.
- B. Related Sections include the following:
 - 1. Division 09 Section "Acoustical Panel Ceilings" for acoustical ceiling panels supported by exposed suspension system and tested for noise reduction.

1.3 DEFINITIONS

- A. NRC: Noise reduction coefficient.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data:
 - 1. Acoustical Wall Panels: For each type of fabric facing, panel edge, core material, and mounting indicated.
- C. Shop Drawings: For fabric-wrapped acoustical wall panels and fabric-wrapped, geometric sound diffusers.
 - 1. Acoustical Wall Panels: Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Include elevations showing panel sizes and direction of fabric weave and pattern matching. Indicate panel edge and core materials.
 - 2. Geometric Sound Diffusers: Include elevations showing panel sizes and direction of fabric weave and pattern matching. Include mounting devices and details.
- D. Samples for Verification: For the following products. Prepare Samples from same material to be used for the Work.
 - 1. Fabric: Full-width by approximately 36-inch- long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
 - 2. Mounting Device: Full-size Sample.
- E. Qualification Data: For manufacturer.

- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of acoustical wall panel.
- G. Maintenance Data: For acoustical wall panels to include in maintenance manuals. Include the following:
 - 1. Fabric manufacturers' written cleaning and stain-removal recommendations.
 - 2. Fabric manufacturers' precautions for cleaning materials and methods that could be detrimental to acoustical wall panels and facings.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing acoustical wall panels similar to those indicated for this Project and with a record of successful in-service performance.
- B. Source Limitations:
 - 1. Acoustical Wall Panels: Obtain acoustical wall panels through one source from a single manufacturer.
 - 2. Geometric Sound Diffusers: Obtain geometric sound diffusers through one source from a single manufacturer.
- C. Fire-Test-Response Characteristics: Panels and diffusers shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 - 2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with fabric, acoustical wall panel and geometric diffuser manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials, panels and diffusers in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
- C. Protect panel and diffuser edges from crushing and impact.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fabric-wrapped acoustical wall panels and geometric diffusers until spaces are enclosed and weatherproof, wet work in spaces is complete and dry,

work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

- B. Lighting: Do not install fabric-wrapped acoustical wall panels and geometric diffusers until a lighting level of not less than 50 fc is provided on surfaces to receive fabric-wrapped acoustical wall panels and fabric-wrapped geometric diffusers.
- C. Air-Quality Limitations: Protect fabric-wrapped acoustical wall panels and fabric-wrapped geometric diffusers from exposure to airborne odors, such as tobacco smoke, and install panels and diffusers under conditions free from odor contamination of ambient air.
- D. Field Measurements: Verify locations of fabric-wrapped acoustical wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 EXTRA MATERIALS

- A. Fabric-Wrapped Acoustical Panels: Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fabric: For each fabric, color, and pattern installed, provide length equal to 5 percent of amount installed, but no fewer than 5 yards.

PART 2 - PRODUCTS

2.1 BACK-MOUNTED, EDGE-REINFORCED, FABRIC-WRAPPED IMPACT RESISTANT ACOUSTICAL WALL PANELS WITH GLASS-FIBER BOARD CORE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Conwed Designscape; Rebound Series.
- B. Panel Construction: dimensionally stable 6-7 PCF fiberglass core, with a 1/16" resilient perforated co-polymer face sheet. Panels are finished with Class A-rated fabric and arrive ready-to-install in any commercial application. Finishes are completely adhered to the face of the panel and returned to the back for a full finished edge. All corners are fully tailored.
- C. Nominal Core Density: 6 to 7 lb/cu. ft.
- D. Facing Material: Fabric from same dye lot; color and pattern as follows:
 - 1. Manufacturer: Maharam.
 - 2. Collection Style and Number: Plait 466052.
 - 3. Color: 001 Cobblestone
 - 4. Fiber Content: 100 percent recycled polyester.
 - 5. Width: 58 inches useable.
 - 6. Flammability: ASTM E 84 Class 1 or A.
- E. Nominal Core Thickness and Overall System NRC: 1 inch.
- F. Panel Width: As indicated on Drawings.

- G. Panel Height: Fabricated height as indicated on Drawings; mounting height as indicated on Drawings.
- H. Panel Edge Detail: Square.
- I. Corner Detail: Square to form continuous profile to match edge detail.
- J. Mounting Method: Back mounted with manufacturer's perimeter adhesive and impaling clips.
- K. Location: Assembly Hall 126

2.2 BACK-MOUNTED, EDGE-REINFORCED, FABRIC-WRAPPED ACOUSTICAL WALL PANELS WITH GLASS-FIBER BOARD CORE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Armstrong; SoundSoak.
 2. Conwed Designscape; Respond A Series.
- B. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back border of dimensionally stable, rigid glass-fiber board core; with edges chemically hardened to reinforce panel perimeter against warpage and damage.
- C. Nominal Core Density: 6 to 7 lb/cu. ft.
- D. Facing Material: Fabric from same dye lot; color and pattern as follows:
 1. Manufacturer: Maharam.
 2. Collection Style and Number: Coin 466233.
 3. Color: 001.
 4. Fiber Content: 100 percent recycled polyester.
 5. Width: 57 inches useable.
 6. Flammability: ASTM E 84 Class 1 or A.
- E. Nominal Core Thickness and Overall System NRC: 1 inch.
- F. Panel Width: As indicated on Drawings.
- G. Panel Height: Fabricated height as indicated on Drawings; mounting height as indicated on Drawings.
- H. Panel Edge Detail: Square.
- I. Corner Detail: Square to form continuous profile to match edge detail.
- J. Mounting Method: Back mounted with manufacturer's standard hook and loop fasteners, secured to substrate.
- K. Location: Multipurpose Library 149

PART 3 - EXECUTION

3.1 CLEANING

- A. Clip loose threads; remove pills and extraneous materials on fabric-wrapped acoustical wall panels and geometric diffuser panels.
- B. Clean panels with fabric facing, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.
- C. Remove surplus materials, rubbish, and debris resulting from acoustical wall panel installation, on completion of Work, and leave areas of installation in a neat and clean condition.

3.2 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that acoustical wall panels and geometric diffuser panels are without damage or deterioration at time of Substantial Completion.
- B. Replace acoustical wall panels and geometric diffuser panels that cannot be cleaned and repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 098413

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SECTION 099000 - PAINTING

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. Exposed exterior items and surfaces with low VOC coatings complying with ME DEP regulations.
 2. Exposed interior items and surfaces with low VOC coatings complying with ME DEP regulations.
 3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Related Sections include the following:
 1. Division 05 Section "Structural Steel Framing" for shop priming structural steel.
 2. Division 05 Section "Steel Decking" for shop finish on metal deck to be field finished.
 3. Division 05 Section "Metal Fabrications" for shop priming ferrous metal.
 4. Division 06 Section "Architectural Woodwork" for surface preparation of interior standing and running trim and shop finishing of architectural casework.
 5. Division 08 Section "Hollow Metal Doors and Frames" for factory priming steel doors and frames.
 6. Division 09 Section "Gypsum Board Assemblies" for surface preparation of gypsum board.
 7. Review all sections for shop primed items requiring field painting.

1.3 DEFINITIONS

- A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
 3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
 4. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
 5. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."

- B. Product Data: For each paint system indicated. Include block fillers and primers.
 - 1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 - 2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
- C. Schedule: Provide schedule of all surfaces to be coated, with prime and finish coat material listed, and manufacturer's recommended wet film thickness.
- D. Samples: For each type of exposed finish required, submit color chips, 3- by 5-inches, matching colors indicated on Finish Schedule.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain block fillers, primers and undercoat materials for each coating system from the same manufacturer as the finish coats.
- B. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and substrate required. Duplicate finish of approved sample Submittals.
 - 1. Architect will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted.
 - a. Wall Surfaces: Provide samples of at least 100 sq. ft.
 - b. Small Areas and Items: Architect will designate items or areas required.
 - 2. After permanent lighting and other environmental services have been activated, apply benchmark samples, according to requirements for the completed Work. Provide required sheen, color, and texture on each surface.
 - a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
 - 3. Final approval of colors will be from benchmark samples.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

- A. Apply paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.
- B. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.
 - 2. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.

1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
 - 1. Quantity: Furnish Owner with not less than 1 gal., of each material and color applied for Owner's use during move in.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.
- B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Benjamin Moore & Company (Moore).
 - 2. PPG Industries, Inc. (PPG).
 - 3. Sherwin-Williams Co. (S-W).
 - 4. Flame Control Coatings, LLC (Flame Control); phone: (716) 282-1399.

2.2 COATINGS MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best quality coating material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers listed in the specification

- schedule. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
2. Where schedule says no substitution, use proprietary product only. Do not propose substitution, as the products from the other manufacturers have been considered, and are not acceptable.
- C. VOC Compliance for Exterior and Interior Paints and Coatings: Provide the manufacturer's formulation for the products specified below that are VOC compliant with the State of Maine Department of Environmental Protection Regulation, "Chapter 151: Architectural and Industrial Maintenance (AIM) Coatings" and the following chemical restrictions expressed in grams per liter:
1. Flat Paints and Coatings: VOC content of not more than 100 g/L.
 2. Non-Flat Paints and Coatings: VOC content of not more than 150 g/L.
 3. Non-Flat Paints and Coatings - High Gloss: VOC content of not more than 250 g/L.
 4. Anticorrosive (Rust Preventative) Coatings: VOC content of not more than 400 g/L.
 5. Clear Wood Coatings:
 - a. Clear Brushing Lacquers: VOC content of not more than 680 g/L.
 - b. Lacquers (Including Lacquer Sanding Sealers): VOC content of not more than 550 g/L.
 - c. Sanding Sealers (Other than Lacquer Sanding Sealers): VOC content of not more than 350 g/L.
 - d. Varnishes: VOC content of not more than 350 g/L.
 6. Dry Fall Coatings: VOC content of not more than 400 g/L.
 7. Fire Resistive Coatings: VOC content of not more than 350 g/L.
 8. Fire Retardant Coatings:
 - a. Clear: VOC content of not more than 650 g/L.
 - b. Opaque: VOC content of not more than 350 g/L.
 9. Industrial Maintenance Coatings (IMC): VOC content of not more than 340 g/L.
 10. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 11. Quick-Dry Enamels: VOC content of not more than 250 g/L.
 12. Quick-Dry Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 13. Specialty Primers, Sealers, and Undercoaters: VOC content of not more than 350 g/L.
 14. Stains: VOC content of not more than 500 g/L.
- D. Colors: Provide color selections made by the Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator and drywall subcontractor present, under which painting will be performed for compliance with paint application requirements.
1. Inspect walls for dents and imperfections prior to painting. Inspect walls again after primer and first coat of paint applied, with Applicator and drywall subcontractor present. Drywall subcontractor shall touch-up as follows:
 - a. Touch-up visible gypsum board imperfections before priming of walls.
 - b. Touch-up imperfections found in field of boards and joints made visible from painting after first finish coat applied.
 2. If unacceptable conditions are encountered, prepare written report, endorsed by Applicator, listing conditions detrimental to performance of work.

3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 4. Application of coating indicates Applicator's acceptance of surfaces and conditions within a particular area.
 5. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of specified finish materials to ensure use of compatible primers.
1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
1. Provide barrier coats over incompatible primers or remove and reprime.
 2. Cementitious Materials: Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze.
 - a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
 - b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
 3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer for opaque finishes.
 - b. Prime, stain, or seal wood to be painted immediately on delivery.
 - c. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
 - d. If transparent (clear or stained) finish is required, backprime with spar varnish.
 4. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's standards.
 - a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.

- b. Touch up bare areas and shop-applied prime coats that have been damaged. Clean with solvents recommended by paint manufacturer and SSPC SP2; and touch up with same primer as the shop coat.
 - 5. Galvanized Surfaces: Uniformly abrade galvanized surfaces with a palm sander and 60 grit aluminum oxide so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
 - a. Clean field welds with nonpetroleum-based solvents complying with SSPC's standards so surface is free of oil and surface contaminants.
- D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
 - 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 - 7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 - 8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 - 9. Sand lightly between each succeeding enamel or varnish coat.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - 2. Omit primer over metal surfaces that have been shop primed and touchup painted, unless indicated otherwise.

3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- C. Paint all exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.
1. Painting includes field painting of exposed bare and covered pipes and ducts (including color-coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment at all locations except mechanical and electrical rooms.
- D. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
1. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- E. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions. Walls shall have roller finish.
1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
 - a. Decorative, perforated stair risers shall be spray painted.
- F. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- G. Mechanical and Electrical Work: Painting of mechanical, plumbing, fire protection, and electrical work is limited to items exposed in occupied spaces (outside mechanical and electrical rooms).
- H. Mechanical, plumbing, and fire protection items to be painted include, but are not limited to, the following:
1. Piping, pipe hangers and supports.
 2. Heat exchangers.
 3. Tanks.
 4. Ductwork, including interior of ductwork visible through air devices.
 5. Insulation.
 6. Motors and mechanical equipment.
 7. Accessory items.

- I. Electrical items to be painted include, but are not limited to, the following:
 - 1. Conduit and fittings.
 - 2. Panelboards.

- J. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

- K. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

- L. Transparent (Clear or Stained) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
 - 1. Provide satin finish for final coats, unless otherwise noted.

- M. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

- N. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

- O. Exterior Ferrous Metal Items to Be Painted Include, but Are Not Limited To, the Following:
 - 1. Exposed structural steel and lintel plates.
 - a. Galvanized single angle lintels do not require painting.
 - 2. Steel doors and frames.
 - 3. Bollards.
 - 4. Metal fabrications; see Division 05 Section "Metal Fabrications."
 - 5. Miscellaneous metal items, including galvanized steel.

- P. Interior Ferrous Metal Items to Be Painted Include, but Are Not Limited To, the Following:
 - 1. Steel doors and frames.
 - 2. Lintel plates and angles.
 - 3. Exposed construction, including metal deck.
 - 4. Metal frames for glass lite kits in wood doors.
 - 5. Access panels (both sides).
 - 6. Metal fabrications; see Division 05 Section "Metal Fabrications."
 - 7. Miscellaneous metal items.

3.4 CLEANING

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

3.5 PROTECTION

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

3.6 EXTERIOR PAINT SCHEDULE

- A. VOC Compliance, General: Provide the manufacturers' formulations for the products specified below that comply with the VOC requirements for the State of Maine Department of Environmental Protection in paragraph 2.2.C of this Section.
- B. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated (galvanized) metal surfaces: Primer is not required on shop-primed items, except steel doors and frames, which require a primer under this specification.
 - 1. Semigloss, Waterborne Alkyd Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, corrosion resistant, single component, acrylic-modified alkyd metal primer applied to galvanized metals not previously shop-primed applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product. Moore and S-W do not have exterior products meeting requirements.
 - 1) PPG: Seal Grip Interior/Exterior Acryl Universal Primer/Sealer 17-921 Series; 1.6 mils DFT.
 - b. First and Second Coats: Semigloss, exterior, single component, waterborne alkyd applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product. Moore does not have exterior products meeting requirements; S-W ProMar 200 Interior Waterbased Acrylic-Alkyd not approved for exterior use.
 - 1) PPG: Speedhide Interior/Exterior WB Alkyd Semi-Gloss 6-1510 Series; 1.5 mils DFT.

3.7 LOW VOC INTERIOR COATINGS

- A. VOC Compliance, General: Provide the manufacturers' formulations for the products specified below that comply with the VOC requirements for the State of Maine Department of Environmental Protection in paragraph 2.2.C of this Section.
- B. Gypsum Board: Provide the following finish systems over interior gypsum board wall surfaces:
 - 1. Flat Acrylic Finish, GPDW Soffits and Ceilings: 2 finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product.
 - 1) Moore: Ben Premium Interior Latex Primer No. W624; 1.2 mils DFT.

- 2) PPG: Speedhide zero 6-4900XI Interior Zero-VOC Latex Sealer; 1.2 mils DFT.
- 3) S-W: ProMar 200 Zero VOC Interior Latex Primer B28W02600 Series; 1.0 mils DFT.
- b. First and Second Coats: Flat, acrylic-latex-based, interior paint applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Ben Premium Interior Latex Flat No. W625; 1.2 mils DFT per coat.
 - 2) PPG: Speedhide zero 6-4110XI Interior Latex Zero-VOC Flat; 1.3 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Flat, B30-600 Series; 1.5 mils DFT per coat.
- 2. Low-Luster (Eggshell), Acrylic-Enamel Finish, Walls: 2 finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product.
 - 1) Moore: Ben Premium Interior Latex Primer No. W624; 1.2 mils DFT.
 - 2) PPG: Speedhide zero 6-4900XI Interior Zero-VOC Latex Sealer; 1.2 mils DFT.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer, B28W02600 Series; 1.0 mils DFT.
 - b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Ben Premium Interior Latex Eggshell No. W626; 1.3 mils DFT per coat.
 - 2) PPG: Speedhide zero 6-4310XI Interior Zero-VOC Latex Eggshell; 1.4 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-2600 Series; 1.7 mils DFT per coat.
- C. Stained Woodwork: Provide the following stained finishes over new, interior woodwork:
 - 1. Waterborne, Satin Polyurethane Finish: 3 finish coats of a waterborne, clear-satin polyurethane over a stain coat. Stain coats WS1 shall match wood doors provided in Division 08 "Wood Doors."
 - a. Stain Coat, WS1: Penetrating, interior wood stain. VOC compliant, applied at spreading rate recommended by the manufacturer. Stain colors WS1 to match finish applied to flush wood doors.
 - 1) WS1: Olympic Interior Oil Based Wood Stain 44500, tinted to match color factory finished door stain (Product used by Marshfield Door Systems Inc.) or approved equal.
 - a. First, Second and Third Finish Coats: Waterborne, polyurethane finish applied at spreading rate recommended by the manufacturer.
 - 1) Moore: Benwood Stays Clear Acrylic Polyurethane No. 423.
 - 2) PPG: Olympic 42786 Premium Interior Water Based Polyurethane Satin Clear.
 - 3) S-W: Minwax Polycrylic Protective Finish Satin Clear.

- D. Ferrous Metal: Provide the following finish systems over ferrous metal. Primer is not required on existing and shop-primed items. Prime bare spots and cracks on ferrous metals.
1. Semigloss, Acrylic-Modified Alkyd Finish or Pre-Catalyzed Waterborne Acrylic Epoxy Finish, All Surfaces except Handrails: 2 finish coats over a primer.
 - a. Primer: Quick-drying, corrosion resistant, single component, acrylic-modified alkyd primer or self cross-linking acrylic primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product.
 - 1) Moore: Advance Waterborne Interior Alkyd Primer No. 790; 1.6 mils DFT.
 - 2) PPG: Pitt-Tech Plus 90-912 Interior/Exterior Industrial DTM Primer; 3.0 mils DFT.
 - 3) S-W: Pro Industrial Pro-Cryl Universal Primer B66-310 Series; 3.0 mils DFT.
 - b. First and Second Coats: Semigloss, single component, acrylic-modified alkyd interior enamel or single-component, pre-catalyzed waterborne acrylic epoxy applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product.
 - 1) Moore: Advance Waterborne Interior Alkyd Gloss No. 794; 1.6 mils DFT per coat.
 - 2) GP: 1506-XXXX Dulux Advanced Oil Interior/Exterior Semi-Gloss Wall & Trim Enamel; 4.0 mils DFT per coat.
 - 3) PPG: Pitt-Glaze WB1 16-510 Interior Semi-Gloss Pre-Catalyzed Water-Borne Acrylic Epoxy; 2.0 mils DFT per coat.
 - 4) S-W: Pro Industrial Pre-Catalyzed Waterbased Epoxy K45-150 Series; 1.5 mils DFT per coat.
 2. Semigloss, Water Based Epoxy Finish, Handrails: 2 finish coats over shop applied primer.
 - a. First and Second Coats: Semigloss, waterborne epoxy or polyamine epoxy finish applied at spreading rate recommended by the manufacturer to achieve a total dry mill thickness of not less than indicated for product.
 - 1) Moore: Waterborne Polyamide Epoxy Gloss Coating No. P42; 3.0 mils DFT per coat.
 - 2) PPG: Pitt-Glaze WB1 16-510 Interior Semi-Gloss Pre-Catalyzed Water-Borne Acrylic Epoxy; 2.0 mils DFT per coat.
 - 3) S-W: Pro Industrial Pre-Catalyzed Waterbased Epoxy K45-150 Series; 1.5 mils DFT per coat.
- E. Overhead Exposed Construction, Including Metal Deck, Steel Joists, Galvanized Duct Work, Conduit and Piping: Provide the following finish system.
1. Flat, Modified Alkyd Rust-Inhibitive Primer: Quick-drying, corrosion resistant, primer/finish over prepaint surface cleaner.
 - a. Prepaint Surface Cleaner: Concentrated alkaline detergent blend for cleaning overhead construction without needing to rinse prior to coating, applied at spreading rate recommended by the manufacturer.
 - 1) GLL: No Rinse Prepaint Cleaner.
 - b. Primer/Finish: Quick-drying, corrosion resistant, primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product.

- 1) Tnemec: Series 115, Uni-Bond DF; no substitution.
- F. Telecommunication, Data and Electrical Backboards: Provide the following finish over plywood:
1. Flat Intumescent Finish: Two finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product.
 - 1) Moore: EcoSpec WB Interior Latex Primer Sealer No. 372; 1.2 mils DFT.
 - 2) SW: Preprite Problock Interior/Exterior Latex Primer\Sealer; 1.4 mils DFT.
 - b. First and Second Coats: Intumescent-type, fire-retardant paint applied at spreading rate recommended by manufacturer to achieve a total dry film thickness of not less than 4 mils; white color for telecommunication and black for electrical.
 - 1) Moore: M59 220 Latex Fire-Retardant Coating.
 - 2) FlameControl: 20-20A Flat Latex Intumescent Coating.
- G. Fire-Rating and Smoke Identification: Identify all 1, 2 and 3-hour fire-rated walls and partitions by stenciling rating on each side of rated walls above ceiling line with 4 inch high letters in red or orange semigloss paint; each rated wall shall be identified at least once and at a spacing not greater than 12 feet o.c. and not more than 5 feet from each end of the wall. Identify all smoke barriers and partitions by stenciling "SMOKE" on each side of walls above ceiling line with 4 inch high letters in bright green semigloss paint; each rated wall shall be identified at least once and at a spacing not greater than 12 feet o.c. and not more than 5 feet from each end of the wall.
1. First Coat: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product.
 - a. Moore: Ben Premium Interior Latex Semi-Gloss No. W627; 1.5 mils DFT.
 - b. PPG: Speedhide zero 6-4510 Interior Zero-VOC Latex Semi-Gloss; 1.3 mils DFT.
 - c. S-W: ProGreen 200 Low VOC Interior Latex Semi-Gloss B31-600 Series; 1.6 mils DFT.

END OF SECTION 099000

SECTION 102113 - TOILET COMPARTMENTS

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 solid-polymer units as follows:
 - 1. Toilet Enclosures: Floor supported, overhead braced, solid polymer.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for concealed wood blocking.
 - 2. Division 10 Section "Toilet and Bath Accessories" for toilet tissue dispensers, grab bars, and similar accessories.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of centerlines of toilet fixtures.

1.4 QUALITY ASSURANCE

- A. Comply with requirements in GSA's CID-A-A-60003, "Partitions, Toilets, Complete."
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 75 or less.
 - 2. Smoke-Developed Index: 450 or less.
- C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOLID-POLYMER UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Accurate Partitions Corporation.
 - 2. Hadrian, Inc.
 - 3. Scranton Products.
- B. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, and with matte finish and homogenous color and pattern throughout thickness of material.
 - 1. Color: As indicated in Materials Legend; if not indicated, as selected by Architect from manufacturer's full range of colors and patterns.
- C. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
- D. Headrail: Extruded anodized aluminum, 1-inch diameter, 0.75 lb/ft., with anti-grip design; attached to wall and pilasters with manufacturer's fittings to produce a rigid installation. All joints in headrails shall be made at a pilaster bracket.
- E. Brackets (Fittings):
 - 1. Full-Height (Continuous) Type: Manufacturer's standard double ear design; extruded aluminum or stainless steel.

2.2 ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
 - 1. Material: Chrome-plated, nonferrous, cast zinc alloy (zamac), clear anodized aluminum or stainless steel.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.3 FABRICATION

- A. Floor-Supported, Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanisms.
- B. Doors: Unless otherwise indicated, provide 24-inch- wide in-swinging doors for standard toilet compartments and 36-inch- wide out-swinging doors with a minimum 32-inch- wide clear opening for compartments indicated to be accessible to people with disabilities.
 - 1. Hinges: Manufacturer's standard self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
 - 2. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.
 - 3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
 - 4. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
 - 5. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch.
 - b. Panels and Walls: 1 inch.
- B. Floor-Supported, Overhead-Braced Units: Bottom of pilasters shall be supported by a continuous floor angle that is full width of pilasters. Install 3 screws through angle into 4-inch wide pilasters, with one additional screw for each additional 4 inches of pilaster width or fraction thereof. Install 2 lag bolts through angle into floor for 4-inch wide pilasters and one additional screw for each additional 4 inches of pilaster width or fraction thereof. Set pilasters with anchors penetrating not less than 2 inches into structural floor, unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with not less than two fasteners. Hang doors to align tops of doors with tops of panels and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open

approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113

SECTION 102238 - OPERABLE PANEL PARTITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manually operated, acoustical panel partitions.
- B. Related Requirements:
 - 1. Division 05 Section "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
 - 2. Division 06 Section "Rough Carpentry" for concealed wood blocking.
 - 3. Division 09 Section "Gypsum Board Assemblies" for sound barrier construction above the ceiling at track.

1.3 DEFINITIONS

- A. STC: Sound Transmission Class.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include the following: material descriptions, construction details, finishes, installation details, and operating instructions for each type of operable panel partition, component, and accessory specified. Include data on acoustical performance, surface-burning characteristics, and durability.
 - 1. Material descriptions, construction details, finishes, installation details, and operating instructions for each type of operable panel partition, component, and accessory specified.
 - 2. Include dimensions and weights for operable panel partitions.
 - 3. Include data on acoustical performance, surface-burning characteristics, and durability.
- B. Shop Drawings: For operable panel partitions.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
 - 3. Indicate conditions at openings and for storage; and required installation, storage, and operating clearances.
 - 4. Show blocking to be provided by others.
- C. Samples for Initial Selection: For each type of exposed material, finish, covering, or facing.
 - 1. Include Samples of accessories involving color selection.

- D. Samples for Verification: For each type of exposed material, finish, covering, or facing, prepared on Samples of size indicated below:
 - 1. Textile Facing Material: Full width by not less than 36-inch- long section of fabric from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat.
 - 2. Panel Facing Material: Manufacturer's standard-size unit, not less than 3 inches square.
- E. Delegated-Design Submittal: For operable panel partitions.
 - 1. Include design calculations for seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

- A. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.
- B. Qualification Data: For qualified Installer.
- C. Seismic Qualification Certificates: For operable panel partitions, tracks, accessories, and components, from manufacturer. Include seismic capacity of partition assemblies to remain in vertical position during a seismic event and the following:
 - 1. Basis for Certification: Indicate whether certification is based on analysis, testing, or experience data, according to ASCE/SEI 7.
 - 2. Detailed description of partition anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: Signed by manufacturers of operable panel partitions certifying that products furnished comply with requirements.
- E. Product Test Reports: For each operable panel partition, for tests performed by a qualified, independent testing agency.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For operable panel partitions to include in maintenance manuals.
 - 1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
 - b. Seals, hardware, track, track switches, carriers, and other operating components.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Panel Finish-Facing Material: Furnish full width in quantity to cover both sides of two panels when installed.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified in writing by the operable panel partition manufacturer as qualified to install the manufacturer's partition systems for work similar in material, design, and extent to that indicated for this Project.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design seismic bracing of tracks to structure above.
- B. Seismic Performance: Operable panel partitions shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the partition panels will remain in place without separation of any parts from the system when subjected to the seismic forces specified."
- C. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
 - 1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, and rated for not less than the STC indicated.
- D. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified independent testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2.2 OPERABLE ACOUSTICAL PANELS

- A. Operable Acoustical Panels: Partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
 - 1. Products: Subject to compliance with requirements, provide one of the following products:
 - a. Modernfold, Inc.; Acousti-Seal Encore Paired-Panel.
 - b. Hufcor Inc.; 600 Series, Model 642.
 - 2. All operable panel partitions on project shall be by same manufacturer.

- B. Panel Operation: Manually operated, individual panels.
- C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Panels shall be constructed with a welded steel frame faced with steel skins with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
 - 1. Steel skins shall be welded to steel frame.
- D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
 - 1. Panel Width: Equal widths.
- E. STC: Not less than 49.
- F. Panel Weight: 8 lb/sq. ft. maximum.
- G. Panel Thickness: Not less than 3 inches.
- H. Panel Materials:
 - 1. Steel Frame: Steel sheet, 0.0508-inch nominal minimum thickness for uncoated steel.
 - 2. Steel Face/Liner Sheets: Tension-leveled steel sheet, 0.0359-inch minimum nominal thickness for uncoated steel.
- I. Panel Closure:
 - 1. Initial Closure: Flexible, resilient PVC, bulb-shaped acoustical seal.
 - 2. Final Closure: Constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal.
- J. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.

2.3 SEALS

- A. General: Provide manufacturer's standard vertical seals, horizontal top and bottom seals, and initial and final closures. Provide seals that produce operable panel partitions complying with performance requirements and the following:
 - 1. Seals made from materials and in profiles that minimize sound leakage.
 - 2. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.
- B. Vertical Seals: Deep-nesting, interlocking astragals mounted on each edge of panel, with continuous PVC acoustical seal.
- C. Horizontal Top Seals: Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track.

- D. Horizontal Bottom Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
 - 1. Automatically Operated for Acoustical Panels: Extension and retraction of bottom seal automatically operated by movement of partition, with operating range not less than 1 inch between retracted seal and floor finish.

2.4 PANEL FINISH FACINGS

- A. General: Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.
 - 1. Apply one-piece, seamless facings free of air bubbles, wrinkles, blisters, and other defects, with invisible seams complying with Shop Drawings for location, and with no gaps or overlaps. Horizontal seams are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
 - 2. Where facings with directional, repeating, or matching grain are indicated, mark facing top and attach facing in same direction.
 - 3. Match facing pattern 72 inches above finished floor.
- B. Vinyl-Coated Fabric Wall Covering: Manufacturer's standard, mildew-resistant, washable, vinyl-coated fabric wall covering; complying with CFFA-W-101-D for type indicated; Class A, Heavy-Duty.
 - 1. Total Weight: Not less than 20 oz./sq. yd.
 - 2. Antimicrobial Treatment: Additives capable of inhibiting growth of bacteria, fungi, and yeasts.
 - 3. Color/Pattern: As selected by Architect from manufacturer's full range.
- C. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.5 SUSPENSION SYSTEMS

- A. Tracks: Steel or aluminum with adjustable steel hanger rods for overhead support, designed for operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
 - 1. Panel Guide: Aluminum guide on both sides of the track to facilitate straightening of the panels; finished with factory-applied, decorative, protective finish.
 - 2. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.
- B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.
 - 1. Multidirectional Carriers - Single Panels: Two all steel trolleys with four steel tired, ball bearing wheels. Non-steel tires are not acceptable.

- C. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.
- D. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.6 ACCESSORIES

- A. Pass Doors: Swinging door built into and matching panel materials, construction, acoustical qualities, finish and thickness, complete with frames and operating hardware. Hinges finished to match other exposed hardware.
 - 1. Accessibility Standard: Fabricate doors to comply with applicable provisions in ICC A117.1 and the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities.
 - 2. Single Pass Door: 36 by 84 inches.
 - 3. Pass-Door Hardware: Equip pass door with the following:
 - a. Door Seals: Sweep floor seals.
 - b. Latchset: Manufacturer's standard roller latch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with ASTM E 557 except as otherwise required by operable panel partition manufacturer's written installation instructions, Drawings, and approved Shop Drawings.
- B. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.
- C. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.
- D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

3.3 ADJUSTING

- A. Adjust operable panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust pass doors to operate smoothly and easily, without binding or warping. Confirm that latches engage accurately and securely without forcing or binding.

- C. Verify that safety devices are properly functioning.

3.4 CLEANING AND PROTECTION

- A. Clean soiled surfaces, vinyl facings, and metal surfaces on completing installation of operable panel partitions, to remove dust, fingerprints, adhesives, and other foreign materials according to manufacturer's written instructions using manufacturer's recommended product.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure operable panel partitions are without damage or deterioration at time of Substantial Completion.
- C. Replace panels that cannot be cleaned and repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.
 1. Test and adjust seals, hardware, carriers, tracks, pass doors, exit signs, and other operable components. Replace damaged or malfunctioning operable components.
 2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 3. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 102238

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SECTION 102800 - TOILET AND BATH ACCESSORIES

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. Toilet and bath accessories.
 - 2. Warm-air, rapid drying, high efficiency, electric hand dryers.
 - 3. Infant-care products.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for concealed wood blocking to support accessories.
 - 2. Division 08 Section "Glazing" for frameless mirrors.
 - 3. Division 09 Section "Tile" for ceramic toilet and bath accessories.
 - 4. Division 10 Section "Toilet Compartments" for integral shower curtain rods and hooks provided with shower and changing compartments.
 - 5. Division 22 Sections for fiberglass shower units with integral grab bars, folding seats, and shower rods.
 - 6. Division 26 Sections for electrical service and connections for hand dryers.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.
- C. Shop Drawings: Include blocking locations and mounting heights identified.
- D. Setting Drawings: For cutouts required in other work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.
- E. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use room and accessory designations indicated in the Toilet and Bath Accessory Schedule in Part 3 and room and accessory designations indicated on Drawings.
- F. Maintenance Data: For accessories to include in maintenance manuals specified in Division 01. Provide lists of replacement parts and service recommendations.
- G. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise approved by Architect.
- B. Insofar as possible, fitting, construction and fabrication of the work shall be executed at shop, ready for delivery and erection at building.
- C. Provide all holes, connections, and fastenings for and to work of other trades abutting, adjoining or intersecting work of this Section.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.

1.6 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer's Hand Dryer Warranty: Written warranty, executed by hand dryer manufacturer agreeing to replace hand dryers that fail in materials or workmanship within specified warranty period.
 - 1. Minimum Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M, G60.
- D. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.
- E. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

- F. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- G. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.2 TOILET ACCESSORIES

- A. Grab Bars: Provide stainless-steel grab bar, concealed mounting with manufacturer's standard flanges and anchors, minimum nominal thickness 0.05 inch, 1-1/2 inches outside diameter for heavy-duty applications, in lengths and configurations indicated.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; B-6806 Series.
 - b. Bradley Corporation; 800 Series.
- B. Channel-Framed Mirror: Fabricate frame from stainless-steel channels in manufacturer's standard polished finish with square corners mitered to hairline joints and mechanically interlocked; size as indicated on Drawings. Mirrors shall be first quality plate-glass conforming to U.S. Commercial Standard CS-27-36 with 2 coats of silver and copper clad. Mirror backs shall be zinc-coated steel.
 - 1. Size: As indicated.
 - 2. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-165 Series.
 - b. Bradley Corporation; Model 781.
- C. Standard Toilet Tissue Dispenser, Surface Mounted (TTD): Provide concealed mounting, stainless-steel roll-in-reserve dispenser with hinged front secured with tumbler lockset with noncontrol delivery with manufacturer's standard theft-resistant spindle designed for 4-1/2- or 5-inch- diameter-core tissue rolls.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-4288.
 - b. Bradley Corporation; Model 5A10.
- D. Liquid Soap Dispenser, Wall Mounted (SD): Horizontally- or vertically-mounted soap dispenser as standard by manufacturer, container body and back Type 304 stainless steel, satin finish. Shall dispense liquid soaps, including foam, 40 fl. oz. capacity, unbreakable refill window, concealed wall fastening, large locked hinged stainless steel filler top, vandal-resistant. Front of dispenser door shall have arced surface; and corners and returns shall be radiused.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-4112.
 - b. Bradley Corporation; Model 6A00.
- E. Waste Receptacle, Recessed: Provide recessed stainless-steel type with projecting receptacle, designed for nominal 4-inch wall depth; with continuous, seamless wall flange.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-43644.
 - b. Bradley Corporation; Model 2A05-10.
- F. Sanitary Napkin Disposal, Surface Mounted, SND2: Provide stainless steel sanitary napkin disposal unit with seamless exposed walls; self-closing top cover; locking bottom panel with

stainless-steel, continuous hinge; and removable, reusable receptacle. Front of dispenser door shall have arced surface; and corners and returns shall be radiused.

1. Products:

- a. Bobrick Washroom Equipment, Inc.; Model B-270.
- b. Bradley Corporation; Model 4A10-11.

G. Sanitary Napkin/Tampon Vendor, Semirecessed, SND1: Type 304 stainless steel cabinet, satin finish, all-welded construction designed for nominal 4-inch wall depth; with seamless door with returned edges and secured by tumbler lockset. Vendor product selection and coin return pushbutton-operation shall be certified ADA-ABA, ICC/ANSI A117.1 compliant. Provide identification reading "Napkins" and "Tampons"; brand-name advertising is not allowed. Capacity not less than 20 napkins and 30 tampons. Single-coin operated; coinage denomination to be determined by Owner.

1. Products:

- a. Bobrick Washroom Equipment, Inc.; Model B-370634 Series.

H. Horizontal, Surface-Mounted Diaper-Changing Station: Diaper-changing station with surface-mounted, mildew-resistant, molded polyethylene body that folds horizontally against wall when not in use; projects not more than 4 inches from wall when closed; and is engineered to support a minimum of 250-lb static weight when opened. Provide unit with pneumatic shock-absorbing operating mechanism and built-in dispenser for sanitary liners.

1. Products:

- a. Bobrick Washroom Equipment, Inc.; Model B-2210.
- b. Bradley Corporation; Model 962-11.

I. Mop and Broom Holder with Utility Shelf: 36-inch- long unit fabricated of minimum nominal 0.05-inch- thick stainless steel with shelf, 8 inches deep; support brackets for wall mounting; three hooks for wiping rags; four spring-loaded, rubber hat, cam-type, mop/broom holders. Provide at each janitor's sink.

1. Products:

- a. Bobrick Washroom Equipment, Inc.; Model B-239.
- b. Bradley Corporation; Model 9933.

2.3 WARM-AIR DRYERS

A. Warm-Air Hand Dryer: Rapid drying, high efficiency, self contained electric unit as follows:

1. Mounting: Surface mounted.
2. Operation: Touch-free infra-red activation.
 - a. Operation Louck-Out Period: 30 seconds.
3. Air Speed at Aperture: 420 mph.
4. Cover Material and Finish: Polycarbonate-ABS casing with antimicrobial molded additive in fascia and blades.
5. Sound Power Level: 81 dB.
6. Electrical Requirements: 120 V, 1400 W.
7. Product: Dyson, Inc.; Airblade dB, Model AB14.
 - a. Color: White.

2.4 FABRICATION

A. General: One, maximum 1-1/2-inch- diameter, unobtrusive stamped manufacturer logo, as approved by Architect, is permitted on exposed face of accessories. On interior surface not

exposed to view or back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

- B. Sections and shapes shall be rolled, formed, drawn, or extruded as required for respective functions.
- C. Molded work shall have sharply defined profile and shall be clean and straight. Plain work shall be leveled, straight and surfaces true and smooth. Edges, angles, and corners shall be square, clean and sharp, unless otherwise detailed.
- D. Fastenings, exposed metal fastenings, and accessories, unless Underwriters prohibit for safety, shall be of same materials, texture, color and finish as the base metal to which applied.
- E. Molds, trim, frames and other metalwork shall be proper dimensions to receive masonry block and tile, plaster, ceramic tile, or other scheduled finishes.
- F. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
- G. Semi-Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners; exposed edges rolled. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.
- H. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab bars shall be screwed to solid wood blocking in stud partitions. Install grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.
- C. Concealed Blocking: Provide concealed wood blocking, 3/4-inch thick plywood covering 32 inch by 32-inch area, in stud walls, including for Owner furnished accessories.

3.2 TOILET ACCESSORIES SCHEDULE

- A. Toilet Accessories in each Single Person Toilet Room (Rooms 106, 122, 136, 137, 146, 148) :
 - 1. Provide channel-framed mirror over lavatory.
 - 2. Provide one soap dispenser (SD).
 - 3. Provide one paper towel dispenser (PTD).
 - 4. Provide one toilet tissue dispenser (TTD).

5. Provide grab bars in configurations shown as indicated. Grab bars mounted on steel framed walls shall be screwed to solid wood blocking in stud partitions.
 6. Provide diaper-changing station in Room 106.
- B. Toilet Accessories in Multi-Person Toilet Rooms (Rooms 105, 107):
1. Provide one soap dispenser (SD) for each lavatory.
 2. Provide one toilet tissue dispenser (TTD) for each water closet.
 3. Provide one combination towel dispenser/waste receptacle.
 4. Provide one warm-air hand dryer.
 5. Provide grab bars in configurations shown at designated water closets. Grab bars mounted on steel framed walls shall be screwed to solid wood blocking in stud partitions.
 6. Provide one sanitary napkin disposal unit (SND2) for each water closet in each Women's Toilet Rooms.
 7. Provide one sanitary napkin vendor (SND1) where indicated in each Women's Toilet Room.
 8. Mirrors provided in Division 08 Section "Glazing."
- C. Custodial Closets:
1. Provide one mop/broom holder.

3.3 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 102800

SECTION 104400 - FIRE-PROTECTION SPECIALTIES

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. Portable fire extinguishers.
 - 2. Fire-protection cabinets for portable fire extinguishers.
 - 3. Mounting brackets for fire extinguishers.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguishers and fire-protection cabinets.
 - 1. Fire Extinguishers: Include rating and classification.
 - 2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- C. Samples for Initial Selection: For fire-protection cabinets with factory-applied color finishes.
- D. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.
- E. Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.
- F. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.
- B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FMG.

- D. Fire-Rated, Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.
- E. Fire Extinguisher Inspection: Prior to installation, professionally inspect all fire extinguishers in accordance with NFPA 10, "Portable Fire Extinguishers" and attach tag to the fire extinguisher verifying inspection and inspection date. Tag shall comply with the requirements of the local authority having jurisdiction. Tag with manufacturing date only is not acceptable.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.6 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty for Fire Extinguishers: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. JL Industries, Inc.
 - 2. Larsen's Manufacturing Company.
 - 3. Potter Roemer; Div. of Smith Industries, Inc.
- B. Fire extinguisher cabinets, fire extinguishers, and mounting brackets shall be from same manufacturer.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Stainless-Steel Sheet: ASTM A 666, Type 304.

- C. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.3 PORTABLE FIRE EXTINGUISHERS

- A. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 - 1. Handles and Levers: Manufacturer's standard.
 - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.4 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
- B. Cabinet Construction: Nonrated and rated as required for wall construction where cabinet is located.
- C. Cabinet Material: Enameled-steel sheet.
- D. Semirecessed Cabinet: Cabinet box partially recessed in walls of shallow depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 - 1. Rolled-Edge Trim: 2-1/2-inch backbend depth.
- E. Cabinet Trim Material: Same material and finish as door.
- F. Door Material: Steel sheet.
- G. Door Style: Vertical duo panel with frame.
- H. Door Glazing: Tempered float glass (clear).
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide projecting lever handle with cam-action latch.
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- J. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
 - 3. Identification: Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER"; lettering complying with authorities having jurisdiction for letter

style, size, spacing, and location; lettering orientation and color as selected by Architect. Locate as indicated by Architect.

K. Finishes:

1. Manufacturer's standard baked-enamel or powder coat for the following:
 - a. Exterior of cabinet, door, and trim, except for those surfaces indicated to receive another finish.
 - b. Interior of cabinet and door.
 - c. Color and Texture: As selected by Architect from manufacturer's full range.

2.5 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 1. Color: Black.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.
 2. Location: Provide for bracket mounted extinguishers in all mechanical rooms and where indicated.

2.6 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 1. Weld joints and grind smooth. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.

- D. 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.

2.8 STEEL FINISHES

- A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.
- B. Baked-Enamel Finish or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- B. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
 - 1. Fire-Protection Cabinets: 54 inches above finished floor to top of cabinet.
 - 2. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
- B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire-protection cabinets.
 - 2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
- D. Identification: Apply decals at locations indicated.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104400

SECTION 105113 - METAL LOCKERS

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. Knocked-down, athletic metal lockers.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for concealed wood support base, blocking, and shims required for installing metal lockers and concealed within other construction before metal locker installation.

1.3 DEFINITIONS

- A. Uncoated Steel Sheet Thicknesses: Indicated as the minimum thicknesses.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show sloping tops, filler panels, recess trim, end panels and other accessories.
 - 2. Include locker identification system.
 - 3. Show dimensions of locker layouts and required lengths and depths for wood and concrete bases.
- D. Samples for Verification: For metal lockers, in manufacturer's standard sizes.
- E. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain metal lockers and accessories through one source from a single manufacturer.
- B. Regulatory Requirements: Where metal lockers 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 not less than 1 shelf located no higher than 54 inches above the floor for side reach.
2. Provide 1 shelf located at bottom of locker no lower than 9 inches above the floor for side reach.
3. Provide hardware that does not require tight grasping, pinching, or twisting of the wrist, and that operates with a force of not more than 5 lbf.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for metal locker installation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify the following by field measurements before fabrication and indicate measurements on Shop Drawings:
 1. Concealed framing, blocking, and reinforcements that support metal lockers before they are enclosed.

1.8 COORDINATION

- A. Coordinate size and location of concrete and wood bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS) Type B, suitable for exposed applications.
- B. Stainless-Steel Sheet: ASTM A 666, Type 304.
- C. Fasteners: Zinc- or nickel-plated steel, slotless-type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.

- D. Anchors: Select material, type, size, and finish required for secure anchorage to each substrate.

2.3 KNOCKED-DOWN, ATHLETIC METAL LOCKERS (Shower Rooms 105A and 107A):

- A. Knocked-Down, Athletic Metal Lockers:
 - 1. Products: Manufacturer's below shall comply with specified minimum gages specified.
 - a. Lyon Workspace Products; Heavy Duty Ventilated Metal Lockers.
 - b. Penco Products, Inc., Subsidiary of Vesper Corporation; Invincible II Lockers.
 - c. Republic Storage Systems Company; Heavy Duty Ventilated Lockers.
- B. Locker Arrangement: As follows:
 - 1. Double tier.
- C. Body: Assembled by bolting body components together using shake-proof permanent fasteners. Fabricate from unperforated, cold-rolled steel sheet with thicknesses as follows:
 - 1. Tops and Bottoms: 0.0528 inch thick, 16 gage, with single bend at edges.
 - 2. Backs: 0.0428 inch thick, 18 gage.
 - 3. Shelves: 0.0528 inch thick, 16 gage, with double bend at front and right-angle single bend at sides and back.
- D. Sides: Manufacturer's standard; 0.0528-inch-thick, 16 gage, cold-rolled steel sheet with manufacturer's standard diamond perforations welded to all four sides.
- E. Frames: Channel formed; fabricated from 0.0528-inch-thick, 16 gage, cold-rolled steel sheet or 0.0966-inch-thick, 12 gage, steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.
- F. Doors: Manufacturer's standard perforated door as follows:
 - 1. Perforated Doors: One-piece, fabricated from 0.0677-inch-thick, 14 gage, cold-rolled steel sheet with manufacturer's standard diamond perforations; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
 - a. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
- G. Hinges: Welded to door and attached to door frame with not less than 2 factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
 - 1. Knuckle Hinges: Steel, full loop, 5 or 7 knuckles, tight pin; minimum 2 inches high. Provide not less than 3 hinges for each door more than 42 inches high.
- H. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond face of door; pry resistant.
 - 1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in cylinder locks, or padlocks; positive automatic and prelocking.
 - a. Latch Hooks: Equip doors 48 inches and higher with 3 latch hooks and doors less than 48 inches high with 2 latch hooks; fabricated from minimum 0.1116-inch-thick steel; welded to full-height door strikes; with resilient silencer on each latch hook.
 - b. Latching Mechanism: Manufacturer's standard rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a

prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

- I. Equipment: Equip each metal locker with identification plate and the following, unless otherwise indicated:
 - 1. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
- J. Accessories:
 - 1. Continuous Sloping Tops: Fabricated from minimum 0.0428-inch- thick, 18-gage, cold-rolled steel sheet; approximately 20-degree pitch.
 - a. Closures: Vertical-end type.
 - b. Sloped top corner fillers, mitered.
 - 2. Filler Panels: Fabricated from 0.0428-inch- thick (18 gauge), cold-rolled steel sheet.
 - 3. Boxed End Panels: Fabricated from 0.0528-inch- thick (16 gauge), cold-rolled steel sheet.
- K. Locker Size: As follows:
 - 1. 15 inches wide by 12 inches deep by 72 inches high, double tier.
- L. Finish: Baked enamel or powder coat.
 - 1. Color(s): As indicated by manufacturer's designations in Materials Legend. Other manufacturers shall provide color from standard and non-standard colors as required to match color indicated.

2.4 FABRICATION

- A. General: Fabricate metal lockers square, rigid, and without warp; with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch.
 - 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet, unless otherwise indicated.
 - 2. Provide fasteners, filler plates, supports, clips, and closures as required for a complete installation.
- B. Unit Principle: Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.
- C. Knocked-Down Construction: Fabricate metal lockers for nominal assembly at Project site using shake-proof nuts and bolts. Factory weld frame members together to form a rigid, one-piece assembly.
- D. Accessible (ADA) Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches above the floor.
 - 2. Where hooks, rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- E. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- F. Identification Plates: Manufacturer's standard etched, embossed, or stamped aluminum plates; with numbers and letters at least 3/8 inch high.
 - 1. Identification of ADA Lockers: Handicapped symbol attached to door.

- G. Continuous Sloping Tops: Fabricated in lengths as long as practicable, without visible fasteners at splice locations; finished to match lockers.
 - 1. Sloped top corner fillers, mitered.
- H. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip joint filler angle formed to receive filler panel.
- I. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
 - 1. Provide one-piece panels for double-row (back-to-back) locker ends.

2.5 STEEL SHEET FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Factory finish steel surfaces and accessories except stainless steel and chrome-plated surfaces.
- C. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond. Use manufacturer's standard methods.
- D. Baked-Enamel Finish: Immediately after cleaning, pretreating, and phosphatizing, apply manufacturer's standard thermosetting baked-enamel finish. Comply with paint manufacturer's written instructions for application, baking, and minimum dry film thickness.
- E. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. If unacceptable conditions are encountered, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion, using concealed fasteners.
 - 2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
 - 3. Anchor back-to-back metal lockers to floor.

- B. Knocked-Down Metal Lockers: Assemble knocked-down metal lockers with shake-proof fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach hooks with at least two fasteners.
 - 2. Attach door locks on doors using security-type fasteners.
 - 3. Identification Plates: Identify metal lockers with identification indicated on Shop Drawings.
 - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
 - 4. Attach filler panels with concealed fasteners. Locate fillers panels where intersecting lockers occur, and between ends of locker runs meeting end walls, corners and obstacles.
 - 5. Attach sloping top units to metal lockers, with closures at exposed ends.
 - 6. Attach boxed end panels with concealed fasteners to conceal exposed ends of nonrecessed metal lockers.
 - 7. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.
- B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit metal locker use during construction.
- C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal locker manufacturer.

END OF SECTION 105113

SECTION 115213 - PROJECTION SCREENS

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 front projection screens.
- B. Related Sections include the following:
 - 1. Division 26 Sections for electrical service and connections including metal device boxes for switches and conduit, where required, for low-voltage control wiring.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures".
- B. Product Data: For each type of screen indicated.
- C. Shop Drawings: Show layouts and types of projection screens. Include the following:
 - 1. Location of screen centerline relative to ends of screen case.
 - 2. Location of wiring connections.
 - 3. Location of seams in viewing surfaces.
 - 4. Drop length.
 - 5. Connections to supporting structure for recess-mounted screens.
 - 6. Anchorage details.
 - 7. Details of juncture of exposed surfaces with adjacent finishes.
 - 8. Accessories.
 - 9. Wiring Diagrams: For electrically operated units.
- D. Maintenance Data: For projection screens to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain projection screens through one source from a single manufacturer. Obtain each screen as a complete unit, including necessary mounting hardware and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver projection screens until building is enclosed and other construction within spaces where screens will be installed is substantially complete and ready for screen installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 FRONT-PROJECTION SCREENS

- A. Manually Operated Screens, General: Manufacturer's standard spring-roller-operated units, consisting of case, screen, mounting accessories, and other components necessary for a complete installation.
 - 1. Screen Mounting: Top edge securely anchored to a 3-inch- diameter, rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle and pull attached to slat by screws.
- B. Electrically Operated Screens, General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Line Voltage Control: Remote, 3-position control switch installed in recessed metal device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
 - a. Provide locking cover plates for switches.
 - 2. Motor in Roller: Instant-reversing motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
 - 3. Products:
 - a. Da-Lite Screen Co. Inc.; Tensioned Large Advantage Deluxe Electrol
 - b. Draper Inc.; Access/Series V Electric Projection Screen
 - 4. Location: Assembly Room 126
- C. Surface-Mounted, Metal Encased, Manually Operated Screens: Units designed and fabricated for surface mounting on wall or ceiling, fabricated from formed steel sheet not less than 0.027 inch thick or aluminum extrusions; with flat back design and vinyl covering or baked-enamel finish. Provide end caps and universal mounting brackets, finished to match end caps.
 - 1. Products:
 - a. Da-Lite Screen Co., Inc.; Model C.
 - b. Draper Inc.; Luma 2.
 - 2. Location: Multipurpose Library 146, Art 132

- D. Screen Material and Viewing Surface:
1. Matte-White Viewing Surface: Peak gain of 0.9 to 1.0, and gain of not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.
 - a. Products:
 - 1) Da-Lite Screen Co., Inc.; Matte White.
 - 2) Draper Inc. Fiberglass Matte White.
 2. Mildew Resistance: Rating of 0 or 1 when tested according to ASTM G 21.
 3. Flame Resistance: Passes NFPA 701.
 4. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
 5. Seams for Stage Screen: Where length of screen indicated exceeds maximum length produced without seams in material specified, provide screen with horizontal seam placed at top of screen at juncture between extra drop length and viewing surface.
 6. Seamless Construction, All Other Locations: Provide screens, in sizes indicated, without seams.
 7. Edge Treatment: Provide black masking borders, except as noted.
 8. Electrically Operated Screen:
 - a. Size of Viewing Surface: 10 feet high with 2 feet of black drop by 16 feet wide.
 9. Manually Operated Screen:
 - a. 6 feet high by 8 feet wide, unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install projection screens at locations indicated to comply with screen manufacturer's written instructions.
- B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
1. Test electrically operated units to verify that screen controls, limit switches, closure, and other operating components are in optimum functioning condition.
 2. Test manually operated units to verify that screen operating components are in optimum functioning condition.

3.2 PROTECTING AND CLEANING

- A. After installation, protect projection screens from damage during construction. If damage occurs despite such protection, remove and replace damaged components or entire unit as required to provide units in their original, undamaged condition.

END OF SECTION 115213

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SECTION 116800 – PLAYGROUND EQUIPMENT AND STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes playground equipment as follows:
 1. Embankment Slide.
 2. Composite Play Set.
 3. Chalk Board.
 4. Pebble Harp.
 5. 3 Tier Collection Table.
 6. Water Pump.
 7. Kiddy Korral.
 8. Step 'N' Scoot Softplay.
 9. Panel Paint Medium.

1.3 DEFINITIONS

- A. Definitions in ASTM F 1487 apply to Work of this Section.
- B. IPEMA: International Play Equipment Manufacturers Association.

1.4 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at the proposed neighborhood center to be constructed at 1342 Congress Street in Portland, Maine.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for installation.
- B. Shop Drawings: For each type of playground equipment.
 1. Include plans, elevations, sections, and attachment details.
 2. Include fall heights and use zones for playground equipment, coordinated with the critical-height values of protective surfacing specified in Section 321816.13 "Playground Protective Surfacing."
 3. Manufacturer's color charts.
 4. Include samples of accessories involving color selection.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of playground equipment.
- B. Material Certificates: For the following items:
 - 1. Shop finishes.
 - 2. Wood-Preservative Treatment: Include certification by treating plant that states type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
- C. Sample Warranty: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For playground equipment and finishes to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm whose playground equipment components have been certified by IPEMA's third-party product certification service.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of playground equipment that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Manufacturer's warranty period to start at date of Substantial Completion is determined by the Landscape Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Playground equipment and components shall have the IPEMA Certification Seal.

2.2 PERFORMANCE REQUIREMENTS

- A. Safety Standard: Provide playground equipment according to ASTM F 1487.

2.3 PLAYGROUND EQUIPMENT

A. Embankment Slide:

1. Columbia Cascade 1650-51-EMB Embankment Slide Shute
 - a. Rotationally-molded, Medium Density Polyethylene, 3/8" Thick for 5' drop in elevation
 - b. Metal parts to be brown powder coated
 - c. Slide color to be tan.
 - d. Entry platform shall be flush with grade

B. Composite Playset:

1. The play structure shall be TimberForm® as manufactured by Columbia Cascade Company, 1300 SW Sixth Avenue, Suite 310, Portland, OR 97201-3464 U.S.A.
2. Deck modules shall be 3 foot 10 inches on center in accordance with the following specifications. Model numbers are for apparatus only and do not include supporting structure or required safety rails unless noted. All fabrication shall take place in an enclosed factory environment by personnel experienced in the manufacture of children's play apparatus.
3. All play equipment wood components shall be manufactured from Playground Equipment Grade Douglas fir timbers, selected by the equipment manufacturer for strength, durability, and appearance
4. Timber posts, beams, and walls shall be Coastal Douglas fir (*Pseudo-tsuga menziesii*), free-of-heart-center (F.O.H.C.). To assure long, useful life, timbers containing the heart center or pith of the log shall not be accepted.
5. SofDecks shall be manufactured of 11 gage (.125" thick) perforated mild steel plate. Each deck unit shall be reinforced with 1/4 inch thick mild steel bar as necessary to insure structural integrity. Corners of each deck shall fit closely with support posts and allow for attachment to posts with supplied lag screws. No sharp metal edges shall be exposed.
6. To guide installation, each TimberForm structure shall be accompanied by bills of materials, written instructions, and an erection plan view drawing to be furnished prior to or with the delivery of the play structure. To facilitate assembly, each part shall be indelibly stenciled with an easily-read identification number keyed to the bills of material and erection drawings. All components shall be shipped unitized, protectively wrapped, banded for mechanical handling and ready for assembly. The timber structure shall be installed entirely upon virgin soil or firm compacted grade.
7. All fabricated metal components to be textured thermoplastic coated shall have edges and ends deburred and ground smooth prior to being finished. Preparation of the steel substrate shall incorporate mechanical cleaning to remove heavy mill scale, varnish, rust, grease, etc.; then a prime coat shall be applied. The ultra-violet stabilized thermoplastic coating shall be applied by the electrostatic process to pre-heated substrate to a thickness of approximately 30 mils then allowed to cure before handling. Final Durometer (hardness) shall be 52 on the D Shore scale in accordance with ASTM D 2240.
8. Exterior surfaces shall be textured to camouflage any scratches or markings. Surfaces intended for passage or sliding shall be finished smooth.
9. The coating powder shall be uniformly applied by the electrostatic method to a thickness of six mils. Promptly after the application of the powder, the coating shall be oven-cured at 400 degrees Fahrenheit to chemically bond the finish to the substrate and to render the color coated surface resistant to abrasion, impact, household chemicals, weathering and rusting.

- C. Chalk Board:
1. Natural Playgrounds Company, Chalk Wall, Model # NMS0-CW
 2. Shipping Weight: 40lbs
 3. Toxicity: Treated with child friendly wood preservative.
 4. Size: 2'-7" w x 4'-6" h frame with 1'-7" w x 2'-9 1/2" panel and a shelf 12" off the ground
 5. Install per manufacture's written instructions.
- D. Pebble Harp:
1. Natural Playgrounds Company, Pebble Harp (Roof & Tray), Model # NMS-PHRT
 2. Shipping Weight: 60 lbs
 3. Toxicity: Treated with child friendly wood preservative.
 4. Cedar construction.
 5. Size: 24"x24"x24" plus the height of the roof.
 6. Install per manufacture's written instructions.
- E. 3-Tier Collection Table:
1. Natural Playgrounds Company, 3-Tier Collection Table, Model # SSC-CT3TIER
 2. Shipping Weight: 45 lbs.
 3. Toxicity: Treated with child friendly wood preservative.
 4. Cedar construction.
 5. Install per manufacture's written instructions.
- F. Water Pump:
1. EIBE Produktion, Acqua Winder Pump, Model # 5662900
 2. Material: Stainless Steel.
 3. 1 crank pump: Stainless Steel, 57x28x116 cm
 4. 1 pass-through valve.
 5. Install per manufacture's written instructions.
 6. Contractor to provide all water connections.
- G. Kiddy Korral:
1. BCI Burke Company, LLC (Kiddy Korral w/out anchors, Model # 580-1278)
 2. Install per manufacture's written instructions.
- H. Step 'N' Scoot:
1. BCI Burke Company, LLC (Step 'N' Scoot Soft Play w/out anchors, Model # 580-1276)
 2. Install per manufacture's written instructions.
- I. Panel Paint Medium:
1. Play Mart, Inc. (Panel Paint Medium 4ft Portable, Model # PE-NNPA-PP2-48a-Port)
 2. Include Portable Bases.
 3. Install per manufacture's written instructions.

2.4 FABRICATION

- A. Provide sizes, strengths, thicknesses, wall thickness, and weights of components as required to comply with requirements in ASTM F 1487. Factory drill components for field assembly. Unnecessary holes in components, not required for field assembly, are not permitted. Provide complete play structures, including supporting members and connections, means of access and egress, designated play surfaces, barriers, guardrails, handrails, handholds, and other components indicated or required for equipment indicated.

- B. Metal Frame: Fabricate main-frame upright support posts from metal pipe or tubing with cross-section profile and dimensions as required. Unless otherwise indicated, provide each pipe or tubing main-frame member with manufacturer's standard drainable bottom plate or support flange. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.
- C. Wood Frame: Fabricate main-frame upright support posts from wood. Fabricate secondary frame members, bracing, and connections from wood, steel, or aluminum.
- D. Composite Frame: Fabricate main-frame upright support posts from metal and plastic. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.
- E. Play Surfaces: Manufacturer's standard elevated drainable decks, platforms, landings, walkways, ramps, and similar transitional play surfaces, designed to withstand loads, made into floor units with slip-resistant finish. Fabricate units in modular sizes and shapes to form assembled play surfaces indicated.
- F. Protective Barriers: Fabricate according to ASTM F 1487. Extend barriers to height above the protected elevated surface according to requirements for use by age group indicated. Fabricate from one or more of the following:
 1. Welded-metal pipe or tubing with vertical bars.
 2. Steel sheet with openings for vision and ventilation.
 3. Metal-pipe or -tubing frame with wire-mesh infill panels.
 4. Semi-Transparent plastic panels with openings.
 5. Vertical wood balusters with metal pipe or tubing or wood frame.
 6. Wood panels with openings for vision and ventilation.

2.5 MATERIALS

- A. Aluminum: Material, alloy, and temper recommended by manufacturer for type of use and finish indicated.
- B. Steel: Material types, alloys, and forms recommended by manufacturer for type of use and finish indicated.
- C. Stainless-Steel Sheet: Type 304; finished on exposed faces with No. 2B finish.
- D. Opaque Plastics: Color impregnated, UV stabilized, and mold resistant.
- E. Transparent Plastic: Abrasion-resistant, UV-stabilized polycarbonate sheet; not less than 3/16 thick.
- F. Post Caps: color to match posts.
- G. Platform Clamps and Hangers: Not less than 0.105-inch nominal thickness.
- H. Hardware: Manufacturer's standard; commercial-quality; corrosion-resistant; hot-dip galvanized steel and iron, stainless steel, or aluminum; of a vandal-resistant design.
- I. Fasteners: Manufacturer's standard; corrosion-resistant; hot-dip galvanized or zinc-plated steel and iron, or stainless steel; permanently capped; and theft resistant.

2.6 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment: Pressure-treat wood products according to AWPA U1 and the following:
 - 1. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

2.7 CAST-IN-PLACE CONCRETE

- A. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete for normal-weight concrete with minimum 28-day compressive strength of 3000 psi (20.7 MPa), 3-inch slump, and ¾ inch maximum-size aggregate.
- B. Concrete Materials and Properties: Dry-packaged concrete mix complying with ASTM C 387/C 387M and mixed at site with potable water, according to manufacturer's written instructions, for normal-weight concrete with minimum 28-day compressive strength of 3000 psi (20.7 MPa), 3-inch (76-mm) slump, and 1-inch- (25-mm-) maximum-size aggregate.

2.8 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils, medium gloss. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
- B. PVC Finish: UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on PVC finish, with flame retardant added, and with minimum dry film thickness of 80 mils. Comply with coating manufacturer's written instructions for pretreatment and application.

2.9 IRON AND STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm). Comply with coating manufacturer's written instructions for pretreatment, applying, and baking.
- B. PVC Finish: UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on PVC finish, with flame retardant added, and with minimum dry film thickness of 80 mils. Comply with coating manufacturer's written instructions for pretreatment and application.

2.10 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for earthwork, subgrade elevations, surface and subgrade drainage, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading required for placing playground equipment and protective surfacing is completed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Play equipment to be installed per manufacturer's directions.
- B. Footings:
 - 1. The Contractor shall do all necessary excavation required for the installation of the play equipment. Excavation shall be defined as the digging of all required footings and the removal of all materials encountered (footings, pavements, earth, boulders, broken concrete pieces, etc.) while digging those footings.
 - 2. Concrete footings shall meet the specifications for concrete as specified under 32 13 13 of these specifications. The depth of the top of the footing depends on the safety surfacing specified. See Drawings.
- C. Equipment shall be assembled to conform to the approved shop drawings. All fastenings shall be made as shown on the drawings and shall be securely tightened. All work shall be done so that no hazardous projections shall be left on the finished work.
- D. Cleanup: Upon completion of the work under this Section, all excess materials and debris resulting from work under this Section shall be cleaned up, removed from the Site, and properly disposed of.
- E. Manufacturer's Guarantees and Insurance
 - 1. Product Liability Insurance: The manufacturer of the playground equipment shall maintain, and have in effect at the time of the completed installation, an insurance policy covering completed operations (Product Liability) with a minimum limit of \$1,000,000.00 (One Million Dollars). A certificate of insurance shall be available to the project owner on request.
 - 2. Guarantees: The manufacturer shall furnish a written guarantee, covering the replacement of any damaged Structures or components, at no extra charge for the period of 15 (Fifteen) years. This guarantee does not cover Structures damaged by improper use or vandalism. Labor is not covered in this guarantee.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Perform inspection and testing for each type of installed playground equipment according to ASTM F 1487.
- C. Playground equipment items will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Notify Landscape Architect 48 hours in advance of date(s) and time(s) of testing and inspection.
- F. Warranties
 - 1. 10-Year Limited Warranty for all stainless steel fasteners, aluminum posts, clamps, beams and caps, against structural failure due to corrosion/natural deterioration or manufacturing defects. This warranty does not include any cosmetic issues or wear and tear from normal use.
 - 2. 15-Year Limited Warranty for all plastic and steel components, against structural failure due to corrosion/natural deterioration or manufacturing defects. This warranty does not include any cosmetic issues or wear and tear from normal use.
 - 3. The Contractor shall warrant that all structures and/or equipment installed will conform in kind and quality to the specifications set forth above, and will be free of defect in workmanship and material.
 - 4. The Contractor shall offer a 10-year limited warranty for all aluminum and all posts, clamps, beams, and caps against structural failure due to corrosion, deterioration, or workmanship (cosmetic issues excluded).
 - 5. The Contractor shall offer a 10-year limited warranty for all plastic and steel components against structural failure due to corrosion, deterioration, or workmanship (cosmetic issues excluded).
 - 6. The Contractor shall offer a 1-year limited warranty for all moving parts, swing seats and swing hangers bumpers and other equipment not included above against failure due to corrosion, deterioration, or workmanship.
 - 7. An authorized representative of the play equipment manufacturer must inspect and approve the completed installation. The play equipment will not be accepted by the play equipment manufacturer or the Owner until they are satisfied with the installation. No additional compensation will be given for any necessary corrective work. Contractor shall submit written certification from Manufacturer's Representative that all play equipment has been installed in accordance with manufacturer's prescribed standards.

END OF SECTION 116800

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manually operated chain-and-clutch roller shades with single rollers.
 - 2. Motor-operated roller shades with single rollers.
- B. Related Requirements:
 - 1. Division 06 Section "Rough Carpentry" for wood blocking for mounting roller shades and accessories.
 - 2. Division 26 Sections for electrical service and connections for motors, controls, limit switches, and other powered devices and for system disconnect switches for motor-operated shades.

1.3 ACTION SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittals Procedures."
- B. Product Data: For each type of product.
 - 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
 - 2. Motorized Shade Operators: Include operating instructions.
- C. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
 - 1. Identify locations where blocking is required for attachment of support hardware for shades.
 - 2. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring. Show locations of roller joints for units that are coupled.
- D. Samples for Initial Selection: For each type and color of shadeband material.
 - 1. Include Samples of accessories involving color selection.
- E. Roller-Shade Schedule: Use same room designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining roller shades and finishes.
 - 2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.

3. Operating hardware.
4. Motorized shade operator.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain all roller shades through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUALLY OPERATED CHAIN-AND-CLUTCH SHADES WITH SINGLE ROLLERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 1. Draper Inc.; Manual Flex Shade.
 2. Mecho Shade Systems; Mecho/5 System.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 1. Bead Chains: Stainless steel.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Chain tensioner, sill mounted.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 1. Roller Drive-End Location: As indicated by Architect during Shop Drawing review.
 2. Direction of Shadeband Roll: Regular, from back of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.

- D. **Mounting Hardware:** Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. **Shadebands:**
 - 1. **Shadeband Material:** Light-filtering fabric.
 - 2. **Shadeband Bottom (Hem) Bar:** Steel or extruded aluminum.
 - a. **Type:** Enclosed in sealed pocket of shadeband material.
 - b. **Color and Finish:** As selected by Architect from manufacturer's full range.
- F. **Installation Accessories:**
 - 1. **Front Fascia:** Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. **Shape:** L-shaped.
 - b. **Height:** Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 4 inches.
 - 2. **Installation Accessories Color and Finish:** As selected from manufacturer's full range.

2.2 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- A. **Products:** Subject to compliance with requirements, provide one of the following:
 - 1. Draper Inc.; Motorized FlexShade 2 System.
 - 2. Mecho Shade Systems; ElectroShade System.
- B. **Motorized Operating System:** Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 - 1. **Electrical Components:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. **Electric Motor:** Manufacturer's standard quiet tubular, enclosed in roller.
 - a. **Electrical Characteristics:** Single phase, 110 V, 60 Hz.
 - 3. **Remote Control:** Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
 - a. **Individual Switch Control Station:** Momentary-contact, three-position, toggle-style, wall-switch-operated control station with open, close, and center off functions.
 - b. **Color:** As selected by Architect from manufacturer's full range.
- C. **Rollers:** Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. **Roller Drive-End Location:** As selected by Architect during Shop Drawing review.
 - 2. **Direction of Shadeband Roll:** Regular, from back of roller.
 - 3. **Shadeband-to-Roller Attachment:** Manufacturer's standard method.

- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.
 - 1. Joints between rollers shall occur at storefront (window) mullions.
- F. Shadebands:
 - 1. Shadeband Material: Light-blocking fabric.
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material .
 - b. Color and Finish: As selected by Architect from manufacturer's full range.
- G. Installation Accessories:
 - 1. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard in height required to enclose roller and shadeband when shade is fully open, but not less than 4 inches.
 - 2. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified, independent testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 - 1. Source: Roller-shade manufacturer.
 - 2. Type: PVC-coated polyester.
 - 3. Weave: Mesh.
 - 4. Weight: Manufacturer's standard, but not less than 18.5 oz./sq. yd.
 - 5. Orientation on Shadeband: Up the bolt.
 - 6. Openness Factor: 1 percent.
 - 7. Color: As selected by Architect from manufacturer's full range.
 - 8. Products:
 - a. Draper Inc.; Phifer SheerWeave - PW4800.
 - b. Mecho Shade Systems; ThermoVeil Vertical Privacy Weave.
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
 - 1. Source: Roller-shade manufacturer.
 - 2. Type: Opaque, close woven fiberglass base textile with sun-resistant vinyl film bonded to each side; fire retardant, washable and stain resistant.
 - 3. Products:
 - a. Draper inc.; SunBloc Series SB9000.
 - b. Mecho Shade Systems; Equinox 0100 Series.
 - 4. Thickness: 0.013 inches.
 - 5. Weight: 12 oz./sq. yd.
 - 6. Color: As selected by Architect from manufacturer's full range.

2.4 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Exterior Windows, Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
 - a. Mounting shall be between storefront opening jambs and shall be mounted to head of opening.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
 - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions. Attach brackets to wood or steel substrates. Attachment to gypsum wallboard only is not permitted. Provide adequate screw length to securely fasten hardware to blocking and substrates. Field verify dimensions before fabricating.
 - 1. Shadebands at Exterior Windows: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
 - 2. Mount shades to the head of the storefront (window) opening between the opening jambs.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

3.6 WINDOW TREATMENT SCHEDULE

- A. Motorized Room Shades: Exterior windows in the following spaces:
 - 1. Assembly Hall 126
- B. Manual Chain and Clutch Room Shades: Exterior windows the following spaces:
 - 1. Every room not with an exterior window not receiving a motorized shade except Vestibule 101, Vestibule 102, Lobby 103.

END OF SECTION 122413

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The fire protection system shall be installed in accordance with the 2010 edition of NFPA.
- B. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Sleeves.
 - 3. Escutcheons.
 - 4. Equipment installation requirements common to equipment sections.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- D. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Mechanical sleeve seals.
 - 2. Escutcheons.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.4 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated or white painted in finished spaces.
- D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - c. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - e. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- L. Verify final equipment locations for roughing-in.

- M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PAINTING

- A. Painting of fire-suppression systems, equipment, and components exposed in finished spaces is specified in Division 09 Section "Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

END OF SECTION 210500

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Pipes, fittings, and specialties.
 2. Fire-protection valves.
 3. Fire-department connections.
 4. Sprinklers.
 5. Alarm devices.
 6. Pressure gages.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventer.
 2. Sprinkler Occupancy Hazard Classifications:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - d. Classrooms, Offices and Public Areas: Light Hazard.

3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m.)
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
4. Maximum Protection Area per Sprinkler:
 - a. Classrooms, Offices and Public Areas: 225 sq. ft. (20.9 sq. m.)
 - b. Storage Areas: 130 sq. ft. (12.1 sq. m.)
 - c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m.)
 - d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m.)
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
5. Total Combined Hose-Stream Demand Requirement: 100 gpm.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Domestic water piping.
 2. HVAC Ductwork.
 3. HVAC hydronic piping.
 4. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets
 5. Structural framing components.
- E. Qualification Data: For qualified Installer.
- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Pipe ends may be factory or field formed to match joining method.
- B. Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

- C. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- D. Cast-Iron Flanges: ASME 16.1, Class 125.
- E. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Victaulic Company.
 - 2. Pressure Rating: 175 psig (1200 kPa minimum).
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
- B. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. Victaulic Company.
 - 3. Standard: UL 1091 except with ball instead of disc.
 - 4. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
 - 5. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 6. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.
- C. Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.

- b. Anvil International, Inc.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Division.
 - f. Globe Fire Sprinkler Corporation.
 - g. Kennedy Valve; a division of McWane, Inc.
 - h. Metraflex, Inc.
 - i. Milwaukee Valve Company.
 - j. Mueller Co.; Water Products Division.
 - k. NIBCO INC.
 - l. Potter Roemer.
 - m. Reliable Automatic Sprinkler Co., Inc.
 - n. Tyco Fire & Building Products LP.
 - o. United Brass Works, Inc.
 - p. Victaulic Company.
 - q. Viking Corporation.
 - r. Watts Water Technologies, Inc.
- 3. Standard: UL 312.
 - 4. Pressure Rating: 250 psig (1725 kPa) minimum 300 psig (2070 kPa).
 - 5. Type: Swing check.
 - 6. Body Material: Cast iron.
 - 7. End Connections: Flanged or grooved.

D. Iron OS&Y Gate Valves:

- 1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. Mueller Co.; Water Products Division.
 - h. NIBCO INC.
 - i. Tyco Fire & Building Products LP.
 - j. United Brass Works, Inc.
 - k. Watts Water Technologies, Inc.
- 3. Standard: UL 262.
- 4. Pressure Rating: 250 psig (1725 kPa) minimum
- 5. Body Material: Cast or ductile iron.
- 6. End Connections: Flanged or grooved.

E. Indicating-Type Butterfly Valves:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:

- a. Anvil International, Inc.
 - b. Global Safety Products, Inc.
 - c. Kennedy Valve; a division of McWane, Inc.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Tyco Fire & Building Products LP.
 - g. Victaulic Company.
- 3. Standard: UL 1091.
 - 4. Pressure Rating: 175 psig (1200 kPa) minimum.
 - 5. Valves NPS 2 (DN 50) and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 - 6. Valves NPS 2-1/2 (DN 65) and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 - 7. Valve Operation: Integral indicating device.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:

- 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
- 2. Pressure Rating: 175 psig (1200 kPa) minimum.

B. Angle Valves:

- 1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire Protection Products, Inc.
 - b. United Brass Works, Inc.

C. Ball Valves:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Fire Protection Products, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Tyco Fire & Building Products LP.
 - i. Victaulic Company.
 - j. Watts Water Technologies, Inc.

2.6 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Body Material: Cast or ductile iron.
3. Size: Same as connected piping.
4. End Connections: Flanged or grooved.

B. Riser Zone Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
3. Standard: UL 193.
4. Design: For horizontal or vertical installation.
5. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages and fill-line attachment with strainer.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. AFAC Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
3. Standard: UL 1726.
4. Pressure Rating: 175 psig (1200 kPa) minimum.
5. Type: Automatic draining, ball check.
6. Size: NPS 3/4 (DN 20).
7. End Connections: Threaded.

D. Double Check Valve Backflow Preventer:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product Watts 774 or comparable product by one of the following:
 - a. Watts.
 - b. Ames.
 - c. Deringer
2. Design: For horizontal or vertical installation.
3. Description: Lead-Free Stainless Steel construction with two testable check valves.

2.7 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Fire Protection Products, Inc.
 - d. GMR International Equipment Corporation.
 - e. Guardian Fire Equipment, Inc.
 - f. Tyco Fire & Building Products LP.
 - g. Wilson & Cousins Inc.
3. Standard: UL 405.
4. Type: Storz, exposed, projecting, for wall mounting.
5. Pressure Rating: 175 psig (1200 kPa) minimum.
6. Body Material: Corrosion-resistant metal.
7. Inlet: Brass with threads matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
8. Caps: Brass, lugged type, with gasket and chain.
9. Escutcheon Plate: Round, brass, wall type.
10. Outlet: Back, with pipe threads.
11. Number of Inlets: One.
12. Escutcheon Plate Marking for wet system: Similar to "•AUTO SPKR"
13. Escutcheon Plate Marking for dry standpipe system: Similar to "•DRY STANDPIPE"
14. Finish: Rough chrome plated or Aluminum.
15. Outlet Size: NPS 4 (DN 100).

2.8 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

- B. Flow Detection and Inspectors Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGF Manufacturing Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 3. Pressure Rating: 175 psig (1200 kPa) minimum.
 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 5. Size: Same as connected piping.
 6. Inlet and Outlet: Threaded.
- C. Flexible, Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. FlexHead Industries, Inc.
 - b. Viking.
 2. Standard: UL 1474.
 3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 4. Pressure Rating: 175 psig (1200 kPa) minimum.
 5. Size: Same as connected piping, for sprinkler.
 6. Flexible hose may be used in lieu of hard piped sections only if acceptable the local authority having jurisdiction.

2.9 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Reliable Automatic Sprinkler Co., Inc.
 2. Tyco Fire & Building Products LP.
 3. Victaulic Company.
 4. Viking Corporation.
- B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 3. Residential Applications: UL 1626.
 4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

- D. Sprinkler Finishes:
1. Acoustical Tile Ceilings: White two piece semi-recessed in all finished spaces.
 2. Chrome upright exposed with chrome cage in the Gymnasium.
 3. Bronze upright in all unfinished spaces such as mechanical rooms (provide cages on sprinklers located under ducts and in Mechanical spaces).
 4. Bronze upright above all ceilings.
 5. Finished spaces without ceilings: White exposed upright or pendant type.
 6. Finished spaces sidewall: White Semi-recessed two piece escutcheon (provide extended coverage sprinkler as required).
 7. Building exterior: Chrome plated.
- E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Acoustical Tile Ceiling Mounting: White painted steel, two piece, semi-recessed with 1-inch (25-mm) vertical adjustment.
 2. Interior Sidewall Mounting: White painted steel, two piece, semi-recessed with 1-inch (25-mm) adjustment.
 3. Exterior Sidewall Mounting: Dry-sidewall, chrome plated, semi-recessed with 1-inch (25-mm) adjustment.
Sprinkler Guards: Chrome plated, tested in conjunction with the sprinkler type installed.
 4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 5. Standard: UL 199.
 6. Type: Wire cage with fastening device for attaching to sprinkler.

2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Potter Electric Signal Company.
 2. Standard: UL 346.
 3. Water-Flow Detector: Electrically supervised.
 4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 5. Type: Paddle operated.
 6. Pressure Rating: 250 psig (1725 kPa).
 7. Design Installation: Horizontal or vertical.

- C. Valve Supervisory Switches:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Potter Electric Signal Company.
 - 2. Standard: UL 346.
 - 3. Type: Electrically supervised.
 - 4. Components: Single-pole, double-throw switch with normally closed contacts.
 - 5. Design: Signals that controlled valve is in other than fully open position.

2.11 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AMETEK; U.S. Gauge Division.
 - 2. Ashcroft, Inc.
 - 3. Brecco Corporation.
 - 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.
- E. Water System Piping Gage: Include "WATER• label on dial face.

2.12 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Stamped Steel or Plastic Split Escutcheons: Polished chrome-plated or white painted finish.

2.13 SLEEVES

- A. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. PVC sleeves in first two paragraphs below may be prohibited by fire authorities having jurisdiction.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
 - 1. Underdeck Clamp: Clamping ring with set-screws.

2.14 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems, Inc.

2. Calpico, Inc.
 3. Metraflex, Inc.
 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Stainless steel.
 3. Connecting Bolts and Nuts: steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 Section.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Fill sprinkler system piping with water.

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
 - I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
- E. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in the center of acoustical ceiling panels.
- B. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.7 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire-department connections.
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.8 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 1. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated or white painted finish.
 2. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated or white painted finish.

3. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.9 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
 - a. Extend sleeves 2 inches (50 mm) above finished floor level.
 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. PVC-pipe or Galvanized-steel-pipesleeves for pipes smaller than NPS 6 (DN 150).
 - b. Galvanized-steel-sheetsleeves for pipes NPS 6 (DN 150) and larger.
 4. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. PVC-pipe or Galvanized-steel-pipesleeves for pipes smaller than NPS 6 (DN 150).
 - b. Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 5. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. PVC-pipe or Galvanized-steel-pipesleeves for pipes smaller than NPS 6 (DN 150).
 - b. Galvanized-steel-sheetsleeves for pipes NPS 6 (DN 150) and larger.

- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.10 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 4. Energize circuits to electrical equipment and devices.
 5. Coordinate with fire-alarm tests. Operate as required.
 6. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.14 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the system.

3.15 PIPING SCHEDULE

- A. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight black-steel pipe with cutgrooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) shall be one of the following:
 - 1. Standard-weight, black-steel pipe with cutgrooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
 - 1. Standard-weight black-steel pipe with cutgrooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.16 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers
 - 2. Rooms with Suspended Acoustical Tile Ceilings: Semi-Recessed sprinklers
 - 3. Hard ceilings (gypsum) and soffits: Concealed plate type sprinklers.
 - 4. Wall Mounting: Sidewall sprinklers.
 - 5. Spaces Subject to Freezing: Pendent, dry sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Semi-Recessed Sprinklers: Factory-painted white, with white two-piece escutcheon.
 - 3. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view. Provide protective cage in mechanical rooms.
 - 4. Building exterior: Chrome plate dry sidewall sprinklers.

END OF SECTION 211313

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SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

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.
- B. Related Sections:
 - 1. Division 23 Section "Common Work Results for HVAC."

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Painting and finishing.
 - 9. Concrete bases.
 - 10. Supports and anchorages.
 - 11. Access panels required for items furnished under Division 21 shall be provided under this Division.
- B. The plumbing contractor is responsible for obtaining the plumbing permit for the project.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PVC: Polyvinyl chloride plastic.

- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Mechanical sleeve seals.
 - 3. Escutcheons.

- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

- B. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- C. Solvent Cements for Joining Plastic Piping:
 1. CPVC Piping: ASTM F 493.
 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 2. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
 3. Aboveground Pressure Piping: Pipe fitting.
- B. Flexible Transition Couplings for Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epcos Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epcos Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Available Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Available Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. PVC Pipe: ASTM D 1785, Schedule 40.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.8 ACCESS PANELS

- A. Selection and installation of access panels shall be in accordance with Division 08 Section "Access Doors and Frames". Access panels shall be standard panels, 12 in. x 16 in. (305 mm x 406 mm) minimum unless indicated otherwise. Panels installed in areas of high moisture concentration, such as restrooms and locker rooms, shall be fabricated of paintable stainless steel or aluminum for corrosion resistance. Access panels in fire-rated construction shall have the same UL rating as the building assembly in which they are installed.
- B. Provide access panels in building construction where required for access to control valves, tempering valves and other related items

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to within 18" of the ceiling to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.

- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
- M. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- N. Verify final equipment locations for roughing-in.
- O. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 220500

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SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220513

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermometers.
 - 2. Gages.
 - 3. Test plugs.
- B. Related Sections:
 - 1. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED DIAL THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Terice H.O. Co. or comparable product by one of the following:
 - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 2. Palmer - Wahl Instruments Inc.
 - 3. Terice, H. O. Co.
 - 4. Weiss Instruments, Inc.
 - 5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

- C. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.
- D. Case: Dry type, stainless steel with 5-inch (127-mm) diameter.
- E. Element: Bimetal coil.
- F. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- G. Pointer: Red or other dark-color metal.
- H. Window: Glass.
- I. Ring: Metal, Brass or Stainless steel.
- J. Connector: Adjustable angle type.
- K. Stem: Metal, for thermowell installation and of length to suit installation.
- L. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Terice H.O., Co. or comparable product by one of the following:
 1. AMETEK, Inc.; U.S. Gauge Div.
 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 3. Palmer - Wahl Instruments Inc.
 4. Terice, H. O. Co.
 5. Weiss Instruments, Inc.
 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- C. Manufacturers: Same as manufacturer of thermometer being used.
- D. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Terice H.O. Co. product indicated on Drawings or comparable product by one of the following:
 1. AMETEK, Inc.; U.S. Gauge Div.
 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 3. Palmer - Wahl Instruments Inc.

4. Terrice, H. O. Co.
 5. Weiss Instruments, Inc.
 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- C. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch (114-mm) diameter.
 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
 4. Movement: Mechanical, with link to pressure element and connection to pointer.
 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 6. Pointer: Red or other dark-color metal.
 7. Window: Glass or plastic.
 8. Ring: Metal, Brass or Stainless steel.
 9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
 11. Range for Fluids under Pressure: Two times operating pressure.
- D. Pressure-Gage Fittings:
1. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
 2. Snubbers: ASME B40.5, NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install thermometers at the inlet and outlet of each domestic, hot-water storage tank.
- B. Install thermometers at suction and discharge of each pump.
- C. Provide the following temperature ranges for thermometers:
 1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions (Minus 1 to plus 82 deg C, with 1-degree scale divisions).
 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions).

3.2 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.
- B. Install dry-case-type pressure gages at suction and discharge of each pump.
- C. Pressure scale: 0 to 100 psi at 2 psi scale divisions.

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- D. Install needle-valve and snubber fitting in piping for each pressure gage.
- E. Install test plugs in tees in piping.
- F. Install permanent indicators on walls or brackets in accessible and readable positions.
- G. Install connection fittings for attachment to portable indicators in accessible locations.
- H. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.
- I. Adjust faces of thermometers and gages to proper angle for best visibility from the floor.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Brass swing check valves.
- B. Related Sections:
 - 1. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set ball and plug valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- E. Valve-End Connections:
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - 2. Threaded: With threads according to ASME B1.20.1.
- F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

- A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide the following:
 - a. Conbraco Industries/Apollo Valves
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: "Lead Free" Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.

- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide the following:
 - a. Conbraco Industries/Apollo Valves
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: "Lead Free" ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball valves.
 - 2. Throttling Service: Ball valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 3 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, brass with bronze trim.
 - 3. Bronze Swing Check Valves: Class 150, bronze disc.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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 hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Copper pipe supports.
- B. Trapeze pipe hangers.
- C. Pipe positioning and acoustical isolation systems.
- D. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Copper pipe supports.
 - 3. Pipe positioning and acoustical isolation systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Carpenter & Paterson, Inc.
 - 3. ERICO/Michigan Hanger Co.
 - 4. Grinnell Corp.
- C. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. Power-Strut Div.; Tyco International, Ltd.
 - 4. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

2.5 PIPE POSITIONING AND ACOUSTICAL ISOLATION SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Available Manufacturers:
 - 1. HOLDRITE Corp.; Hubbard Enterprises.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings or copper on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
- F. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.
- H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 3. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 4. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- J. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- K. Use pipe positioning and acoustical isolation systems in walls and pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Pipe Positioning and Acoustical Isolation System Installation: Install support devices to make rigid and quiet supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- H. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - 3. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - 4. Insert Material: Length at least as long as protective shield.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

END OF SECTION 220529

SECTION 220533 - TEMPERATURE MAINTENANCE FOR PLUMBING PIPING

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 plumbing piping temperature maintenance for freeze prevention, domestic hot-water-temperature maintenance, and ice melting in rain leaders with the following electric heating cables:
 - 1. Self-regulating, parallel resistance.
- B. Related Sections include the following:
 - 1. Division 22 Section "Domestic Water Piping."

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
 - 1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DOMESTIC HOT WATER SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Raychem "HWAT-Plus" model HWAT-R2, (red jacket color) : Raychem is a division of Tyco Thermal Controls.
- B. Heating Element: Pair of parallel No. 16 AWG, tinned stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled "Rayclic" connection kits. Provide "Ray-Clic-LE" lighted end seal at the end of each circuit.
- C. Cable shall be capable of crossing over itself once without overheating.
- D. Cable Cover: Tinned-copper braid, and polyolefin outer jacket with UV inhibitor.
- E. Nominal Operating Temperature: 120 degrees.
- F. Capacities and Characteristics:
 - 1. Maximum Heat Output:
 - 2. Volts: 208V.
 - 3. Phase: One.
 - 4. Hertz: 60.
 - 5. Maximum circuit length: 500 feet with 30 amp circuit breaker.

2.2 CONTROLS

- A. Programmable Controller for Domestic Hot-Water-Temperature Maintenance:
 - 1. DigiTrace "ACCS-30 System", ACCS-PCM2-5 pre-programmed multi-circuit controllers with Remote User Interface Terminal ACCS-UIT2.
 - 2. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control system workstation.
 - 3. Twelve control parameters.
 - 4. Alarm signals.
 - 5. Each ACCS-PCM2-5 shall control up to five circuits.
 - 6. Provide one RTD-10CS remote temperature sensor for each circuit.

2.3 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, cable ties, pre-manufactured connection kits, all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Refer to Division 22 Section "Identification for Plumbing Piping and Equipment."
- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
 - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Install the following types of electric heating cable for the applications described:
 - 1. Temperature Maintenance for Domestic Hot Water: Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

- A. The entire installation of the cable and associated equipment is the responsibility of Division 22. Electrical connections all inclusive shall be performed by a licensed electrical installer in accordance with the manufacturer's instructions and the requirements of Division 26.
- B. Electric Heating Cable Installation for Temperature Maintenance for Domestic Hot Water:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed. Comply with manufacturers instructions for testing the cable.
 - 2. Install insulation over piping with electric heating cables according to Division 22 Section "Plumbing Insulation."
 - 3. Install warning tape on piping insulation where piping is equipped with electric heating cables.
 - 4. Install one remote temperature sensor directly onto the pipe on the opposite side of the heat trace and a minimum of 25 feet from the origin of the circuit.
 - 5. See further testing requirements below.
 - 6. Heat trace shall be carried down to the fixture rough-in in the wall.

- C. Set field-adjustable switches and circuit-breaker trip ranges.
- D. Protect installed heating cables, including non-heating leads, from damage.

3.4 CONNECTIONS

- A. Connections shall be made with manufactured powered connection, powered splice, powered tee, cross kit, tee kit, and lighted end seal connection kits.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."
- C. Electrical connections all inclusive shall be performed by a licensed electrical installer in accordance with the manufacturer's instructions and the requirements of Division 26.

3.5 FIELD QUALITY CONTROL

- A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 1. Test cables for electrical continuity and insulation integrity before energizing.
 - 2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
 - 3. The manufacturer's factory representative shall visit the project three times per circuit to do inspections and instructional meetings.
- B. The entire system shall be inspected by the manufacturer's factory representative and only after acceptance may the piping be insulated. Notify Architect 48 hours (min.) prior to manufacturer's inspection. Provide documentation of manufacturer's inspection and acceptance of all circuits and lengths of cabling for inclusion into the Owner's Manual.
- C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. The entire system shall be installed in strict accordance with all the manufacturer's specifications and recommendations.
- F. Provide testing for the heat trace as indicated below (per manufacturer's recommendations): Heating cable shall be tested with a 2,500 Vdc megohmmeter (megger) between the heating cable bus wires and the heating cable metallic braid. While 2,500 Vdc megger test is recommended, the minimum acceptable level for testing is 1,000 Vdc.
 - 1. This test should be performed two times.
- G. After installation of heating cable and completion of circuit fabrication kits (including all splice kits) but prior to installation of thermal insulation.
- H. After installation of thermal insulation but prior to installation of ceilings.
- I. The minimum acceptable level for the megger readings is 20 megohms, regardless of the circuit length.

- J. All tests shall be witnessed by the construction manager for the project, the heating cable manufacturer or authorized representative and the engineer for the architect.
- K. Continuity and resistance tests shall be conducted per the manufacturer's recommendations and the results documented for inclusion in the Owner's Manuals.

END OF SECTION 220533

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Equipment labels.
 2. Warning signs and labels.
 3. Pipe labels.
 4. Valve tags.
 5. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm).

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
1. Tag Material: Brass, 0.032-inch (0.8-mm minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
- B. Pipe Label Color Schedule:
 - 1. Domestic Cold Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 2. Domestic Hot Water, and Hot Water Return Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 - 3. Natural Gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches (38 mm), round.
 - b. Hot Water: 1-1/2 inches (38 mm), round.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - c. Natural Gas: Natural.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Fiberglass.
 - 2. Tapes.
 - 3. Securements.
 - 4. Corner angles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 4. Detail field application for each equipment type.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Fiberglass, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F (454 deg C) Materials: lass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Fiberglass Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 SEALANTS

- A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.

2.4 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches (75 mm).
 3. Thickness: 11.5 mils (0.29 mm).
 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches (50 mm).
 3. Thickness: 6 mils (0.15 mm).
 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.5 CORNER ANGLES

- A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Keep insulation materials dry during application and finishing.
- F. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- G. Install insulation with least number of joints practical.
- H. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- I. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- J. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- K. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- L. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- M. For above ambient services, do not install insulation to the following:
 1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping".

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 6. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

3.6 FIBERGLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Not used.
2. Install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Place PVC cover fitting over the elbow and secure with bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Not used.
2. Install sections of pipe insulation, to a thickness equal to adjoining pipe insulation.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FINISHES

- A. Insulated piping located in the mechanical rooms shall be covered and sealed with white PVC jacketing.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS ½ and NPS ¾ : Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - 2. NPS 1 (DN 25) and NPS 1-1/4 (DN 32): Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - 3. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- B. Domestic Hot Water:
 - 1. NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
 - 2. NPS 1-1/4 (DN 32) : Insulation shall be the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1-1/2 inch (38 mm) thick.
 - 3. NPS 1-1/2 (DN 40) and NPS 2 (DN 50) : Insulation shall be the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1-1/2 inch (38 mm) thick.
- C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Pre-molded closed cell urethane, white color.

END OF SECTION 220700

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SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Water meters.
 - 3. Escutcheons.
 - 4. Sleeves and sleeve seals.

1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
 - 1. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and threaded ends.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
- B. Copper Pressure-Seal-Joint Fittings:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide the following product:
 - a. Viega.

2. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 PIPING JOINING MATERIALS

- A. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

2.4 TRANSITION FITTINGS

- A. General Requirements:
 1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.5 WATER METERS

- A. Water Meter:
 1. Manufacturers:
 - a. Coordinated with the owner.
 2. Description:
 - a. Standard: AWWA C700.
 - b. Pressure Rating: 150-psig (1035-kPa) working pressure.
 - c. Body Design: Nutating disc; totalization meter.
 - d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility.
 - e. Remote read type: Required.
 - f. Case: Bronze.
 - g. End Connections: Flanged.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.
- C. Install domestic water piping level and plumb.
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- G. Install piping adjacent to equipment and specialties to allow service and maintenance.
- H. Install piping to permit valve servicing.
- I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

3.3 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 (DN 50) and smaller.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
- B. Support vertical piping and tubing at base and at each floor.

- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
 6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
 7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- E. Install supports for vertical copper tubing every 10 feet (3 m).
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
 3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
 4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
 5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
 6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
 7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
 8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
- G. Install supports for vertical steel piping every 15 feet (4.5 m).

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to water piping provided by division 33.
 1. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - a. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - b. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 - c. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.6 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.

- B. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
- C. Escutcheons for Existing Piping:
 - 1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
 - 2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.9 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 5. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

1. Aboveground domestic water piping, NPS 3 and smaller, shall be one of the following:
 - a. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper pressure-seal joints.

3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves for piping NPS 3" and smaller.
 - 2. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves refer to division 23.
 - 3. Drain Duty: Hose-end drain valves.

- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

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SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

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 domestic water piping specialties:
 1. Vacuum breakers.
 2. Backflow preventers.
 3. Temperature-actuated water mixing valves.
 4. Strainers.
 5. Outlet boxes.
 6. Hose bibbs.
 7. Wall hydrants.
 8. Drain valves.
 9. Water hammer arresters.
 10. Trap-seal primer valves.
- B. Related Sections include the following:
 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
 2. Division 22 Section "Domestic Water Piping" for water meters.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 01 through 09."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze.

2.2 BACKFLOW PREVENTERS

- A. Main water Service Entrance: Reduced-Pressure-Principle Backflow Preventers:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts Model LF909, or a comparable product by one of the following:
 - a. Watts Industries, Inc.; Water Products Div.
 - b. Ames Co.
 - c. FEBCO; SPX Valves & Controls.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.
 - 4. Water Entrance Size: (2) 2" NPS (DN).
 - 5. Design Flow Rate: 75 gpm (L/s).
 - 6. Pressure Loss at Design Flow Rate: 12 psig.
 - 7. Body: Epoxy coated cast iron unibody with plastic seats.
 - 8. End Connections: Threaded for NPS 2 (DN 50) and smaller.
 - 9. Configuration: Designed for horizontal, straight through flow.
 - 10. Valves: OS&Y
 - 11. Relief Valve: stainless steel seat and trim
 - 12. Test Cocks: Lead Free bronze body ball valve

2.3 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
 - 1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.

2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
 - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
6. Drain: Factory-installed, hose-end drain valve.

2.4 OUTLET BOXES

A. Refrigerator/Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Oatey.
2. Mounting: Recessed.
3. Material and Finish: Plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
5. Supply Shutoff Fitting: Supply Shutoff Fitting: NPS 1/2 (DN 15) independent ball valve with integral hammer arrestor on valve and NPS 1/2 (DN 15) copper, water tubing.

A. Indirect Waste Receptor Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Oatey.
 - b. Symmons Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
2. Mounting: Recessed.
3. Material and Finish: Plastic box and faceplate.
4. Drain: NPS 2 (DN 50) standpipe and P-trap for direct waste connection to drainage piping.
5. Provide trap primer supply to the receptor.

2.5 HOSE BIBBS

A. Hose Bibbs:

1. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following: Chicago Faucet model 293-E27CP.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Polished Chrome.
4. Seat: Slow Compression, replaceable.
5. Supply Connections: NPS 1/2 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig (860 kPa).
8. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

9. Finish for Equipment Rooms: Chrome plated.
10. Finish for Service Areas: Chrome plated.
11. Finish for Finished Rooms: Chrome plated.
12. Operation for Equipment Rooms: Operating key.
13. Operation for Service Areas: Operating key.
14. Operation for Finished Rooms: Operating key.
15. Include operating key with each operating-key hose bibb.
16. Include wall flange with each chrome-plated hose bibb.

2.6 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Woodford Manufacturing Company.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Standard: ASME A112.21.3M for concealed -outlet, self-draining wall hydrants.
4. Pressure Rating: 125 psig (860 kPa).
5. Operation: Loose key.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS 3/4.
8. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
9. Box: Deep, flush mounting with cover.
10. Box and Cover Finish: Polished nickel bronze.
11. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
12. Nozzle and Wall-Plate Finish: Polished nickel bronze.
13. Operating Keys(s): One with each wall hydrant.

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.

9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.8 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. PPP Inc.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Standard: ASSE 1010 or PDI-WH 201.
4. Type: Copper tube with piston.
5. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.9 TRAP-SEAL PRIMER SYSTEMS TP-1

A. Trap-Seal Primer Systems:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Precision Plumbing Products Model MBP-500-115V.
 - a. PPP Inc.
 - b. Zurn Plumbing Products Group.
4. Standard: ASSE 1044,
5. Piping: NPS 3/4, ASTM B 88, Type L (DN 20, ASTM B 88M, Type B); copper, water tubing.
6. Cabinet: Surface-mounting steel box with stainless-steel cover with integral trap primer, timer control, manual switch.
7. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
8. Vacuum Breaker: ASSE 1001.
9. Number Outlets: Up to Four.
10. Size Outlets: NPS 1/2 (DN 15).
11. Operation: Set to operate once per 24 hour period.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Backflow preventers shall be accessible from a standing position on the floor.
 - 3. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 4. Do not install bypass piping around backflow preventers.
- C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install thermometers and water regulators if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- G. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- H. Install water hammer arresters in water piping according to PDI-WH 201.
- I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow
- J. Install drainage-type, trap-seal primer valves as lavatory trap or flushometer with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."
- C. Connect wiring according to Division 26.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Primary, thermostatic, water mixing valves.
 - 2. Primary water tempering valves.
 - 3. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

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SECTION 221316 - SANITARY WASTE AND VENT PIPING

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 for soil, waste, sanitary vent piping inside the building including vents through the roof:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
- B. Soil, Waste, and Vent Piping: 10-foot head of water 30 kPa or 5 psi.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 PEX TUBE AND FITTINGS FOR TRAP PRIMER DRAINS

- A. PEX Distribution System: ASTM F 877, SDR 9 tubing.
 - 1. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Aboveground, soil and waste piping shall be the following:
 - 1. PVC pipe, PVC socket fittings, and solvent-cemented joints.
- B. Aboveground, vent and grease vent piping shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Underground, soil, waste, and vent piping shall be the following:
 - 1. PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- D. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- H. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- I. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- E. Maximum spans below were taken from MSS SP-69 for water service and from model plumbing codes. Most restrictive piping and spacing dimensions are shown.
- F. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and 5 (DN 100 and 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
 - 4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
- G. Install supports for vertical PVC piping every 48 inches (1200 mm).
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

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SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

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 sanitary drainage piping specialties:
 - 1. Cleanouts.
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Fixtures".

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Metal Floor Cleanouts FCO:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product by Watts or one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 3. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
 - 4. Size: Same as connected branch.
 - 5. Type: Threaded, adjustable housing.
 - 6. Body or Ferrule: Cast iron.
 - 7. Clamping Device: Not required.
 - 8. Outlet Connection: Inside calk.
 - 9. Closure: Plastic plug.
 - 10. Adjustable Housing Material: Cast iron with threads.
 - 11. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 - 12. Frame and Cover Shape:
 - a. FCO: Round
 - 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 - 14. Standard: ASME A112.3.1.
 - 15. Size: Same as connected branch.
 - 16. Coordinate cleanout top design with floor surface.

- B. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Watts CO-480-RD or a comparable product by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 3. Standard: ASME A112.36.2M. Include wall access.
 4. Size: Same as connected drainage piping.
 5. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 6. Closure: Countersunk plug.
 7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 8. Wall Access: Round, stainless-steel cover plate with screw.
 9. Wall Access: Round stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

- A. Floor Drains FD:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:
 - a. Watts Drainage Products Inc.
 - b. Zurn Plumbing Products Group; Specification Drainage Operation.
 3. Standard: ASME A112.6.3
 4. Pattern: Floor drain.
 5. Body Material: Gray iron.
 6. Seepage Flange: Required.
 7. Anchor Flange: Required.
 8. Clamping Device: Required.
 9. Outlet: Bottom.
 10. Backwater Valve: Not required.
 11. Coating on Interior and Exposed Exterior Surfaces: Not required.
 12. Sediment Bucket: Not required.
 13. Top or Strainer Material: Nickel bronze.
 14. Top of Body and Strainer Finish: Nickel bronze.
 15. Top Shape: Round.
 16. Dimensions of Top or Strainer: 6" round.
 17. Top Loading Classification: Heavy Duty
 18. Funnel: Not required.
 19. Inlet Fitting: Not required.
 20. Trap Material: PVC.
 21. Trap Pattern: Standard P-trap.
 22. Trap Features: Trap-seal primer valve drain connection.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 - 1. Description: Shop or field fabricate, PVC Schedule 40, soil-pipe fittings. Include P-trap, and riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 - 2. Size: Same as connected waste piping.
- B. Floor-Drain, Trap-Seal Primer Fittings:
 - 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.
 - 3. Trap primer connections may be made to the tailpiece of the floor drain.
- C. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 100 feet for all piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221413 - FACILITY STORM DRAINAGE PIPING

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 storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water 30 kPa or 5 psi.

1.5 SUBMITTALS

- A. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Aboveground, storm drainage piping NPS 8 to 12 shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Underground storm drainage piping NPS 6 (DN 150) and smaller shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- E. Underground, storm drainage piping NPS 8 to 12 shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Solid-wall, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.

3.3 PIPING INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Drainage Piping."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

- D. Floor cleanouts shall be provided at 100 foot intervals for horizontal piping.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.
- G. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- H. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- I. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.
- J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- K. Install PVC storm drainage piping according to ASTM D 2665.
- L. Install underground PVC storm drainage piping according to ASTM D 2321.
- M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs: According to the following:

- a. MSS Type 1, adjustable, steel clevis hangers.
- 3. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- E. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
 - 4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
 - 5. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
- F. Install supports for vertical PVC piping every 48 inches (1200 mm).
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa) 5 psi. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221413

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SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

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 storm drainage piping specialties inside the building:
 1. Cleanouts.
 2. Roof drains.
 3. Miscellaneous storm drainage piping specialties.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Metal Floor Cleanouts FCO:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product by Watts or one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.

- d. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
4. Size: Same as connected branch.
5. Type: Threaded, adjustable housing.
6. Body or Ferrule: Cast iron.
7. Clamping Device: Not required.
8. Outlet Connection: Inside calk.
9. Closure: Plastic plug.
10. Adjustable Housing Material: Cast iron with threads.
11. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
12. Frame and Cover Shape:
 - a. FCO: Round
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.

B. Cast-Iron Wall Cleanouts

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Watts CO-480-RD or a comparable product by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Standard: ASME A112.36.2M. Include wall access.
4. Size: Same as connected drainage piping.
5. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
6. Closure: Countersunk plug.
7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
8. Wall Access: Round, stainless-steel cover plate with screw.

2.2 ROOF DRAINS

A. Metal Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:
 - a. Watts Drainage Products Inc.
 - b. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Standard: ASME A112.21.2M.
4. Pattern: Roof drain.
5. Body Material: Cast iron.
6. Dimensions of Body: 15" with top set deck plate.
7. Combination Flashing Ring and Gravel Stop: Required.
8. Flow-Control Weirs: Not required.
9. Outlet: Bottom
10. Dome Material: Aluminum
11. Extension Collars: 5" extension to match the insulation thickness.
12. Underdeck Clamp: Not required

- 13. Sump Receiver: Not required

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 100 feet (15 m) for all piping
 - 4. Locate at base of each vertical storm conductor.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install through-penetration firestop assemblies in plastic conductors at floor penetrations.
- F. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
 - 1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- G. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

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SECTION 221613 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 40 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Building:
 - 1. Downstream of the exterior gas meter: 7" water column.
- C. Delegated Design: Design seismic restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated. All gas piping larger than 2" in size shall be seismically braced in accordance with ASCE 7.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.

3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Dielectric fittings.
5. Mechanical sleeve seals.
6. Escutcheons.

B. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

C. Qualification Data: For qualified professional engineer.

D. Welding certificates.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.8 PROJECT CONDITIONS

Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated stainless-steel tubing with polymer coating.
 - 5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
 - 6. End Fittings: Zinc-coated steel.
 - 7. Threaded Ends: Comply with ASME B1.20.1.
 - 8. Maximum Length: 72 inches (1830 mm).

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

- B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig (862 kPa).
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
 - 6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

- C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig (862 kPa).
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Watts
 - b. Nibco
 - c. Conbraco Industries, Inc.; Apollo Div.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig (4140 kPa).
 - 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 DIELECTRIC FITTINGS

- A. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.

- d. McDonald, A. Y. Mfg. Co.
 - e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - f. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig 1034 kPa.
 3. Combination fitting of copper alloy and ferrous materials.
 4. Insulating materials suitable for natural gas.
 5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.6 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.7 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
 3. Pressure Plates: Carbon steel.
 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.8 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw.
 1. Finish: Polished chrome-plated.

2.9 LABELING AND IDENTIFYING

- A. Gas piping shall be labeled.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Locate valves for easy access.
- F. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install escutcheons at penetrations of interior walls, ceilings, and floors.
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - d. Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

- e. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
 - f. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- J. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 3. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.

- S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gauges for HVAC Piping."

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 2. Cut threads full and clean using sharp dies.
 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

- B. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
 2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
 5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).
- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
 1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
 2. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
 3. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

3.7 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.9 PAINTING

- A. Comply with requirements in Division 09 Section “Painting” 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: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
 - d. Color: Gray.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- B. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- C. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- E. Valves in branch piping for single appliance shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 221613

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SECTION 221619 - SOIL GAS VENTING

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 soil gas piping inside the building:
 - 1. Pipe, fittings and soil gas exhaust fans.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:

1.5 SUBMITTALS

- A. Product Data: For pipe, fittings, and soil gas exhaust fans.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 SOIL GAS EXHAUST FAN COMPONENTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Fantech model FR160, white color, 115 volts, 6" PVC pipe connector with flexible couplings or a comparable product by one of the following:
 - 1. Fantech or approved equal.
- D. Check Point Mitigation Alarm: Alarm shall incorporate an audible alarm, green and red light readout, factory preset to activate when the vacuum pressure falls below 0.25" W.C., low voltage. The alarm shall be located in an the Boiler Room.
- E. The exhaust fans shall run continuously.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground soil gas piping NPS 6 (DN 150) and smaller shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Underground soil gas piping NPS 4 shall be the following:
 - 1. Schedule 40 perforated PVC pipe, PVC socket fittings, and solvent-cemented joints.

2. Provide perforated piping in the crushed stone layer below the slab and vapor barrier.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Make changes in direction for soil gas piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
- C. Lay buried soil gas piping within the crushed stone for air permeation to occur.
- D. Install soil gas piping at the following minimum slopes, unless otherwise indicated:
 1. Soil Gas Piping: 2 percent upward toward the vent terminal.
- E. Install underground PVC storm drainage piping according to ASTM D 2321.
- F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. MSS Type 1, adjustable, steel clevis hangers.
 3. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

- F. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 4 (DN 100): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
 - 2. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
- G. Install supports for vertical PVC piping every 48 inches (1200 mm).
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect underground soil gas piping to the exterior piping.
- C. Connect soil gas piping to roof drains and soil gas specialties.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test soil gas piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced soil gas piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test soil gas piping, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa) 5 psi. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect vents during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221619

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SECTION 223400 - FUEL-FIRED DOMESTIC WATER HEATERS

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 fuel-fired water heater:
 1. Natural gas water heater.
 2. Water heater accessories.
 3. Intake and exhaust flue with accessories. Refer to Section 235100 "Breechings, Chimneys, and Stacks".

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Product Certificates: For each type of commercial water heater, signed by product manufacturer.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For water heaters to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 01.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Commercial, Gas Water Heaters:
 - 1) Tank: 5 years.
 - 2) Controls and Other Components: Three years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GAS WATER HEATER

- A. Description: Comply with ANSI Z21.10.3/CSA 4.3, except storage is not required.
 - 1. Available Manufacturers:
 - a. HTP Heat Thermal Products
 - b. A.O Smith
- B. Basis of Design: HTP Phoenix.
- C. Description: Natural gas water heater shall be, minimum 95% thermal efficiency, a storage capacity of 119 gallons, an input rating of 40,000 to 199,000 BTUs per hour, a recovery rating of 237 gallons per hour (gph) at 100°F rise.
 - 1. Design:
 - a. Tank: 316 Stainless Steel.
 - b. Tappings: ASME B1.20.1 pipe thread.
 - c. Pressure Rating: 150 psig (1035 kPa).
 - d. Insulation: Comply with ASHRAE/IESNA 90.1-2004.
 - e. Burner: For use with water heaters and for natural gas.

- f. Automatic Ignition:
- g. Temperature Control: Adjustable digital controller.
- h. Jacket: Metal with enameled finish.
- 2. Capacity and Characteristics:
 - a. Temperature Setting: 140 deg F.
 - b. Fuel Gas Input: 40,000 btu/h min demand to 199,000 btu/h max demand.
 - c. Gas Pressure Required at Burner: 11.0 inches water column.
 - d. Electrical Characteristics:
 - 1) Volts: 120.
 - 2) Phase: Single.
 - 3) Hertz: 60.
 - e. Minimum intake Vent and exhaust flue Diameter: 3".
 - f. Flue Material: AL29-4C Stainless Steel Pipe from the heater to the concentric vent fitting.
 - g. Options:
 - 1) Five Year Warranty.
 - 2) Optional Condensate neutralizing kit: (7450P-212).
 - 3) 3" PVC Concentric Vent Kit (KGAVT0601CVT).

2.3 WATER HEATER ACCESSORIES

- A. Thermal Expansion Tank:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Amtrol model or comparable product by one of the following:
 - a. AMTROL Inc.
 - b. Taco, Inc.
 - 2. Description: Stamped steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 4. Capacity and Characteristics:
 - a. Working-Pressure Rating: 150 psig (1035 kPa).
 - b. Air Precharge Pressure: 70.
- B. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
- C. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
- D. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
- E. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.
 - 1. Gas Water Heaters: ANSI Z21.22/CSA 4.4

- A. Description: Comply with ANSI Z21.10.3/CSA 4.3.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install gas water heaters according to NFPA 58.
- C. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
- D. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
- E. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.
- F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- G. Install pressure gage(s) on inlet and outlet piping of commercial, fuel-fired water heater piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Wire and Cable."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters. Refer to Division 01.

END OF SECTION 223400

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SECTION 224000 - PLUMBING FIXTURES

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 conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories and sinks.
 - 2. Fixture supports.
 - 3. Dishwasher air-gap fittings.
 - 4. Water closets.
 - 5. Urinal.
 - 6. Lavatories.
 - 7. Stainless steel sinks.
 - 8. Service Basin.
- B. Related Sections include the following:
 - 1. Division 10.
 - 2. Division 22 Section "Domestic Water Piping Specialties" and "Sanitary Waste Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
 - 3. Division 22 Section "Emergency Plumbing Fixtures."
 - 4. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- C. FRP: Fiberglass-reinforced plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Plastic Mop-Service Basins: ANSI Z124.6.
 - 2. Stainless-Steel Sinks: ASME A112.19.3.
 - 3. Vitreous-China Fixtures: ASME A112.19.2M.
- G. Comply with the following applicable standards and other requirements specified for sink faucets:
 - 1. Faucets: ASME A112.18.1.
 - 2. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 3. NSF Potable-Water Materials: NSF 61.
 - 4. Pipe Threads: ASME B1.20.1.
 - 5. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - 6. Supply Fittings: ASME A112.18.1.
 - 7. Brass Waste Fittings: ASME A112.18.2.

- H. Comply with the following applicable standards and other requirements specified for shower faucets:
 1. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 2. Faucets: ASME A112.18.1.
 3. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 4. Hose-Coupling Threads: ASME B1.20.7.
 5. Manual-Control Antiscald Faucets: ASTM F 444.
 6. Pipe Threads: ASME B1.20.1.
 7. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 8. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1.
 3. Dishwasher Air-Gap Fittings: ASSE 1021.
 4. Brass Waste Fittings: ASME A112.18.2.
 5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 1. Dishwasher Air-Gap Fittings: ASSE 1021.
 2. Flexible Water Connectors: ASME A112.18.6.
 3. Floor Drains: ASME A112.6.3.
 4. Hose-Coupling Threads: ASME B1.20.7.
 5. Off-Floor Fixture Supports: ASME A112.6.1M.
 6. Pipe Threads: ASME B1.20.1.
 7. Plastic Toilet Seats: ANSI Z124.5.
 8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 2. Warranty Period for Commercial Applications: Three year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets : L-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Basys solar powered faucet.
2. Description: ADA compliant, sensor activated, electronic faucet. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 0.5 gpm (1.5 L/min).
 - d. Mounting: Deck.
 - e. Valve Handle: None.
 - f. Inlet(s): NPS 3/8 (DN 10) tubing, with NPS 1/2 (DN 15) male adaptor.
 - g. Spout: Rigid type.
 - h. Operation: Sensor.
 - i. Power Source: Solar/battery system.
 - j. Drain: Grid model McGuire model 1149WC offset with flat grid strainer.
 - k. Trap: JR Smith, "PRIME-EZE" trap primer p-trap (where shown on the plans).
 - l. Tempering Device: With faucet

2.2 SINK FAUCETS

A. Sink Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucet or comparable manufacturer from the following:
 - a. Chicago Faucets.
 - b. Zurn
 - c. Moen
2. Description: Refer to plans for model numbers.
 - a. Body Material: General-duty, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.
 - d. Mounting: Deck.
 - e. Handle(s): Lever.
 - f. Inlet(s): NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter.
 - g. Spout Outlet: Aerator.
 - h. Vacuum Breaker: Not required.
 - i. Operation: Ceramic disc noncompression, manual.

2.3 MOP BASIN FAUCETS

A. Mop Basin Faucets MB-1 and wall mounted service faucet SF-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucet or a comparable product by one of the following:
 - a. Chicago Faucets.
 - b. Zurn
 - c. Moen

2. Description: polished chrome plated solid cast brass faucet with atmospheric vacuum breaker spout with pail hook, wall brace and 3/4" male garden hose thread outlet, lever handles.
 - a. Body Material: Cast brass.
 - b. Finish: Polished chrome plate.
 - c. Mounting: Wall Mounted.
 - d. Handle(s): Lever.
 - e. Inlet(s): NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter.
 - f. Operation: Ceramic disc noncompression, manual.
 - g. Drain: See fixture descriptions and plans.

2.4 FIXTURE SUPPORTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide Zurn or one of the following:
 1. MIFAB Manufacturing Inc.
 2. Smith, Jay R. Mfg. Co.
 3. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 4. Zurn Plumbing Products Group; Specification Drainage Operation.
- C. Water-Closet Supports:
 1. Description: Watts or equal, Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
 2. ADD Alternate #1: Provide Watts or equal model ISCA-141-3, Thin Wall Carrier, 3" waste, 2" vent, vertical drain.

2.5 WATER CLOSETS

- A. Water closets and flush valves shall be provided by the same manufacturer.
- B. Water Closets, WC-1:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.
 - c. Zurn
 - d. Sloan
 2. Description: HET, wall hung, elongated high efficiency toilet, 1.28 gpf, ADA compliant, back-outlet, top spud, vitreous-china fixture.
 - a. Supply: NPS 1 chrome-plated brass or copper with screwdriver stop.
 - b. Style: Diaphragm type flushometer with hydro-powered electronic sensor.
 - 1) Bowl Type: Wall hung, elongated with high efficiency siphon-jet design.
 - 2) Design Consumption: 1.28 gal./flush (4.8 L/flush).
 - 3) Color: White.

- c. Fixture Support: Water-closet support combination carrier.
- 3. Flushometer: (Basis of design) Sloan, exposed flushometer, automatic sensor operation. Flushometer for water closet type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
 - a. Internal Design: Diaphragm or Piston operation.
 - b. Style: Exposed.
 - c. Inlet Size: NPS 1”.
 - d. Trip Mechanism: automatic sensor operated with manual over-ride button.
 - e. Consumption: 1.28 gal./flush.
 - f. Tailpiece Size: NPS 1-1/2”.
 - g. Power: Hydro-powered or solar with battery back-up.

2.6 TOILET SEATS

- A. Toilet Seats.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide Church or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Bemis Manufacturing Company.
 - c. Church Seats.
 - d. Kohler Co.
 - e. Zurn.
 - 3. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic.
 - b. Configuration: Open front without cover.
 - c. Size: Elongated.
 - d. Hinge Type: CK, check.
 - e. Class: Heavy-duty commercial.
 - f. Color: White.

2.7 URINALS

- A. Urinals and flush valves shall be provided by the same manufacturer.
- B. Urinals, U-1:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard low flow, wall hung urinal with top spud or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.
 - c. Zurn.
 - 2. Description: Wall mounting, top spud, vitreous-china fixture designed for flushometer valve operation.
 - a. Type: Washout.
 - b. Strainer or Trapway: Open trapway with integral trap.
 - c. Design Consumption: 0.5 gpf low flow.
 - d. Color: White.

- e. Supply Spud Size: NPS 3/4 (DN 20).
 - f. Outlet Size: NPS 2 (DN 50).
 - g. Flushometer: Hydropowered electronic flushometer.
 - h. Fixture Support: Urinal chair carrier.
3. Flushometer: (Basis of design) Sloan, exposed flushometer, automatic sensor operation. Flushometer for water closet type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
- a. Internal Design: Diaphragm or Piston operation.
 - b. Style: Exposed.
 - c. Inlet Size: NPS 3/4".
 - d. Trip Mechanism: Automatic sensor operated with manual over-ride button.
 - e. Consumption: 0.5 gal./flush.
 - f. Tailpiece Size: NPS 3/4".
 - g. Power: Hydro-powered or solar with battery back-up.

2.8 LAVATORIES

A. Lavatory L-1:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard, or product by another comparable manufacturer.
- 2. Description: Accessible, undermount vitreous china, one piece design, wall-mounted, solid surface fixture with integral trap cover.
 - a. Color: White.
 - b. Faucet: Lavatory L-1.
 - c. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
 - d. Drain: Grid.
 - e. Drain Piping: NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40) chrome-plated, cast-brass P-trap; NPS 1-1/2 (DN 40) tubular brass waste to wall; and wall escutcheon.
 - f. Protective Shielding Guard(s): Integral with fixture.
 - g. Fixture Support: Lavatory L-1.

2.9 COMMERCIAL SINKS

A. Commercial Sinks:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay or a comparable product by one of the following:
 - a. Just Manufacturing Company.
- 2. Description: one-compartment, under-counter mounted, stainless-steel commercial sink with center drain location, ADA compliant.
 - a. Metal Thickness: 18 gauge.
 - b. Faucet Holes: N.A.
 - c. Compartment(s):
 - 1) Drain: Removable cup drain.
 - a) Location: Center Rear of compartment.
 - d. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; tubular brass waste to wall; and wall escutcheon(s).
 - e. Provide overhang mounting detail.

2.10 SERVICE BASINS

A. Service Basins, MR-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Fiat or a comparable product by one of the following:
 - a. Stern-Williams Co., Inc.
 - b. Swan Corporation.
 - c. Zurn Plumbing Products Group; Light Commercial Operation.
 - d. Florestone.
2. Description: Flush-to-wall, floor-mounting, terrazzo fixture with rim guard.
 - a. Shape: Square.
 - b. Size: 24 by 24 inches .
 - c. Height: 10 inches .
 - d. Wall Guards: stainless steel wall guards, two sides plus corner bracket by 12” high.
 - e. Rim Guard: Stainless on all top surfaces.
 - f. Faucet: MB-1.
 - g. Drain: Grid with NPS 2 (DN 50) outlet.
 - h. Accessories: Mop and hose brackets.

2.11 INDIVIDUAL SHOWERS

A. Roll-In One Piece Shower, SH-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Aqua Bath, or a comparable product by one of the following:
 - a. Aqua Bath Company, Inc.
 - b. Praxis Industries, Inc.; Aquarius Products.
 - c. LASCO Bathware.
2. Description: Transfer stall, Accessible, one piece acrylic construction, dome top, integral ceiling light, shower enclosure with molded-in soap dish, slip-resistant surface, factory installed shower rod, grab bars, fold up seat and weighted antibacterial curtain.
 - a. Surround: One piece.
 - b. Color: White.
 - c. Drain Location: Center.
 - d. Accessibility Options: Include grab bar. Seat is not required.
 - e. Faucet: Shower SH-1.
 - f. Drain: Grid, NPS 2 (DN 50).
 - g. Provide white, weighted, anti-bacterial curtain.
 - h. Provide optional dome light in ceiling.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- C. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- D. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- E. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Operate and adjust high temperature limit stops on faucets. Replace damaged and malfunctioning units.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities.

END OF SECTION 224000

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

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 emergency plumbing fixtures:
 - 1. Hand-held drench hoses.
 - 2. Recessed eye/face wash station in wall with shower.
- B. Related Sections include the following:
 - 1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
 - 2. Division 22 Section "Sanitary Waste Piping Specialties" for floor drains.
 - 3. Division 22 Section "Plumbing Fixtures".

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Tepid: 85 degrees F.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act" ; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.6 EMERGENCY EYE/FACE WASHES AND DRENCH HOSE STATIONS

- A. Hand-Held Drench Hoses, EEW-1
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Guardian Model G5046BP or a comparable product by one of the following:
 - a. Encon Safety Products.
 - b. Guardian Equipment Co.
 - c. Speakman Company.
 - 3. Description: Accessible Plumbed, wall-mounting, hand-held drench hose with wall bracket dual head, stay open valve, clip-in handle for eyewash and drench hose with 12' long coiled retractable hose.
 - a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Stay-Open Lever Handle.
 - d. Hose: Coiled nylon.
 - e. Spray Heads: Twin.
 - f. Provide blocking in wall to support the unit.

1.7 SOURCE QUALITY CONTROL

- A. Certify performance of plumbed emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 2 - EXECUTION

2.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Provide wood blocking in the wall behind each EEW-1 unit to support the wall bracket.
- B. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- C. Install fixtures level and plumb.
- D. Fasten fixtures to substrate.
- E. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- F. Install thermometers in supply and outlet piping connections to equipment. Thermometers are specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- H. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

2.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

2.4 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

C. Report test results in writing.

2.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 224500

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

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 water coolers and related components:
 - 1. Pressure water coolers.

1.3 DEFINITIONS

- A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.

1.4 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" Public Law 101-336, "Americans with Disabilities Act" ; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Water Coolers EWC-1
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay or a comparable product by one of the following:
 - a. Elkay Manufacturing Co.
 - b. Halsey Taylor.
 - c. Oasis Corporation.
 - 3. Description: Flexi-Guard bubbler, Accessible, ARI 1010, Pressure with bubbler, wall-mounting water cooler for adult and child-mounting height.
 - a. Cabinet: Bilevel with two attached cabinets, stainless steel cabinets.
 - b. Bubbler: One, with flexible bubbler hood, adjustable stream regulator, located on each cabinet deck.
 - c. Control: Push bar. No-touch sensor for bottle filler.
 - d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
 - e. Filter: None
 - f. Drain(s): Grid with NPS 1-1/2 minimum horizontal waste and trap complying with ASME A112.18.1.
 - g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 1) Capacity: 8.0 gph of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
 - 2) Electrical Characteristics: 120-V ac; single phase; 60 Hz.
 - h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.

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

3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Sections for "Grounding and Bonding."
- D. Connect wiring according to Division 26 Sections for "Wire and Cable".

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.

2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide labor, materials, accessories, and other related items as required to complete operations in connection with the complete installation of the HVAC and mechanical systems as indicated on the Drawings and as specified herein.

1.2 RELATED REQUIREMENTS

- A. Conditions of the Contract apply to the work, including the work of this Division. Examine Contract Documents for requirements affecting the work.
- B. Provide cooperation with and assistance to, the Commissioning Agent as specified under “Responsibilities” in Division 01 Section “General Commissioning Requirements.”
- C. Provide cooperation with and assistance to, the Testing and Balancing (TAB) Agent specified in Division 01 Section “Testing, Adjusting, and Balancing for HVAC.”

1.3 MECHANICAL PRE-CONSTRUCTION MEETING

- A. Conduct a mechanical conference at Project site to comply with requirements of Division 01 Section “Project Management and Coordination” and the following:
 - 1. At least 14 days prior to beginning of mechanical work, conduct a meeting to review detailed requirements for mechanical systems installation and testing requirements. Review mechanical Drawings and Specifications, discuss project specific details and requirements, and review and discuss expectations for quality control. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with mechanical systems installation to attend conference, including, but not limited to, the following:
 - a. General Contractor's superintendent.
 - b. Mechanical Subcontractors' project managers.
 - c. Mechanical Subcontractors' job foremen.
 - d. Sheetmetal job foreman.
 - e. Plumbing job foreman.
 - f. Controls job foreman.
 - g. Project mechanical Engineer/designer.
 - h. Job clerk.
 - i. Architect's construction administrator.

1.4 DRAWINGS

- A. The general location of the apparatus and the details of the work are indicated on the Drawings. Exact locations not indicated shall be determined at the site as the work progresses and shall be subject to the Architect's approval.

- B. It is not intended that the Drawings shall show every pipe, pipe rise, pipe drop, duct rise, duct drop, pipe fitting, duct fitting, or appliance, but it shall be a requirement to furnish, without additional expense, material and labor necessary to complete the systems in accordance with the design intent and with the highest possible quality available.

1.5 ALTERATIONS

- A. Execute alterations, additions, removals, relocations, new work, and other related items as indicated or required to provide a complete installation in accordance with the intent of the Contract Documents, including changes required by building alterations.
- B. Existing work disturbed or damaged by the alterations or the new work shall be repaired or replaced to the Architect's satisfaction and at no additional cost to the Owner.
- C. Existing ductwork, piping, and other systems indicated to be removed, shall be removed from the site. Cap off existing services remaining. The Owner retains the right to ownership of heating and ventilating equipment scheduled to be removed; store such equipment where requested by the Owner. Material not retained by the Owner shall be removed from the site.

1.6 CONTINUITY OF SERVICE

- A. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted service for the building or any of its locations. Any unavoidable conditions requiring reduced building capacity shall be arranged for by programming with the Owner's duly authorized representative at the building subject to the Architect's approval. If necessary, temporary work shall be installed to provide for the condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal service shall be performed during an overtime period to be scheduled with the Owner. Costs for overtime work shall be included in the bid.

1.7 REQUIREMENTS

- A. Installation Instructions: Obtain manufacturer's printed installation instructions to aid in properly executing work on major pieces of equipment. Install equipment in accordance with manufacturer's recommendations.
- B. Objectionable Noise, Fumes and Vibration:
 - 1. Mechanical and electrical equipment shall operate without creating objectionable noise, fumes, or vibration, as determined by the Architect.
 - 2. If such objectionable noise, fumes, or vibration is produced and transmitted to occupied portions of building by apparatus, piping, ducts, or any other part of mechanical and electrical work, make necessary changes and additions, as approved, without extra cost to Owner.
- C. Equipment Design and Installation:
 - 1. Uniformity: Unless otherwise specified, equipment or material of same type or classification, used for same purposes, shall be product of same manufacturer.
 - 2. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog number shall be designed in conformity with ASME, IEEE, or other applicable technical standards, suitable for maximum working pressure, and with neat and finished appearance.

3. Installation: Erect equipment aligned, level and adjusted for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements may be made, as approved.

D. Hanging of Equipment, Ductwork and Piping:

1. Support equipment, ductwork and piping from the top chord of bar joists at the "Panel Points" or from the top flange of beams. Piping 2" (51 mm) nominal and smaller may be supported from the bottom chord of the bar joists at the "Panel Points" or from the bottom flange of the beams.

E. Protection of Equipment and Materials: Responsibility for care and protection of materials and mechanical work rests with the Contractor until the entire project has been completed, tested and the project is accepted by the Owner.

F. Foundations:

1. Ceiling Mounting: Where ceiling mounting is indicated or specified, use suspended platform or strap hangers, bracket or shelf, whichever is most suitable for equipment and its location. Construct of structural steel members, steel plates, or rods, as required; brace and fasten to building structure or to inserts as approved, or as detailed.
2. Where floor mounting is indicated, locate equipment on 4 inch high reinforced concrete pad of adequate size with anchors and base plates as required, on pressure-treated sleepers, or on structural steel frame as detailed. The corners of pads shall be chamfered 1/2 inch. Pad and steel sizes and location shall be coordinated with the approved equipment.

1.8 ACCESS PANELS

- A. Access panels required for items furnished under Division 23 shall be provided under this Division.
- B. Access panels shall be standard panels, 12 in. x 16 in. minimum unless indicated otherwise. Door shall be flush type of 14-gauge steel hinged to 16-gauge frame with drywall bead. Panels installed in areas of high moisture concentration, such as locker rooms, near plumbing fixtures, food preparation areas, or outdoors, shall be fabricated of paintable stainless steel or aluminum for corrosion resistance.
- C. Access panels in fire-rated construction shall have the same UL rating as the building assembly in which they are installed.
- D. Provide access panels in building construction where required for access to duct access doors or other components such as valves, air vents, actuators, volume dampers, motorized dampers in ductwork, duct smoke detectors, and other related items.

1.9 ELECTRIC WORK

- A. Provide motors, pilot lights, controllers, limit switches, and other related items for equipment provided under Division 23.
- B. Except as noted, required line switches, fused switches, and other related items and necessary wiring to properly connect equipment to motors and switches shall be furnished and installed under Division 26, Electric.

- C. Provide complete wiring system for automatic temperature controls as specified under Section Division 23 Section “Instrumentation and Controls for HVAC.”
- D. Wiring shall conform to the requirements of the National Electrical Code.

1.10 FIRESTOPPING

- A. Firestopping for penetrations of ductwork, piping and equipment through fire rated and smoke rated building assemblies, including but not limited to partitions, walls, floors, ceilings, and roofs, shall be furnished and installed under this Section.
- B. Selection of firestopping materials and installation of firestopping materials shall be in accordance with Division 07 Section “Penetration Firestopping.” Coordinate with other trades for a consistent installation.
- C. Refer to Architectural Drawings for locations of fire rated building assemblies.

1.11 SUBMITTALS

- A. After award of Contract and before installation, submit for approval Shop Drawings, bulletins, Product Data, Samples, and other related items.
- B. Submit Shop Drawings and Product Data as required in each Section. Submittal shall include physical data and performance data required to verify compliance with the Contract Documents.
- C. Submit Samples as required in each Section, and as indicated on the Drawings. These will generally be retained by the Architect/Engineer, unless otherwise indicated. Contractor may request these items returned; provide return shipping for returns.
- D. Submit Mock-Ups as required in each Section, and as indicated on the Drawings. For general mock-up procedures, refer to Division 01 Section “Quality Requirements.” Deliver to the Architect/Engineer for review if so indicated. Provide return shipping.
- E. Architect/Engineer’s review will not include the review, coordination, or verification of dimensions or quantities; these shall be the responsibility of the Contractor.

1.12 SUBSTITUTIONS

- A. Comply with provisions of the Instructions to Bidders and General Conditions.
- B. The first item listed under “Acceptable Manufacturers”, “Approved Manufacturers” or “Manufacturers” is the design basis.
 - 1. Other manufacturers listed may be used in the base bid, but conformance with details of the Specifications, as well as dimensional and electrical data, shall be verified by the Contractor.
 - 2. Architect/Engineer has not verified that each listed manufacturer has the ability to provide an acceptable substitution for the basis-of-design product. Contractor may not assume that substitutions will be approved.
 - 3. Modifications required as a result of differences between the design basis item and the submitted and approved item must be approved by the Architect and made at the Contractor's

expense. As an example, if a rooftop HVAC unit is submitted and approved and if the unit's dimensions and weight are different from those of the unit which was used as the design basis, the Contractor shall be responsible for building structural modifications required to accommodate the submitted and approved unit, at no additional cost to the Owner.

4. When, in the Architect or Engineer's opinion, architectural or engineering services are necessary for the coordination of substituted items, the Contractor shall reimburse the Owner for the cost of these services.
5. For items which have no manufacturers listed, any item conforming with the Contract Documents is acceptable.

C. Substitutions from manufacturers or providers which are not listed may be proposed within the time allowed in the General Conditions of the Specifications.

1. The exception to this is products for which the list of manufacturers or providers is limited by the wording "no substitutions" or similar wording.

1.13 COORDINATION

A. Coordinate scheduling, submittals, and Work of the various Sections of Specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Divisions having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. In finished areas, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

E. Coordinate completion and clean-up of work of separate Sections in preparation for Substantial Completion.

F. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.14 REQUESTS FOR ARCHITECT'S CADD DRAWINGS

A. In lieu of generating their own CADD drawings, the Contractor may elect to use the Architect's electronic copies of CADD drawings for the purpose of developing coordination drawings, developing control system graphics or for other reasons that pertain to the requirements of this Contract. If the Contractor elects to utilize the Architect's electronic copies of CADD drawings, the electronic files shall be purchased from the Architect at the Architect's current billing rate per drawing. The Contractor shall provide payment and shall sign a release-of-liability form before electronic CADD drawings are released.

1.15 CLEANING

- A. Remove debris from site daily.
- B. Material and pieces of equipment shall be turned over to the Owner free of dust and dirt, both inside and out.
- C. At the completion of the Project, equipment shall have a clean, neat appearance of factory finish by cleaning or repainting as required.
- D. At the completion of the Project, surfaces exposed to view shall have a clean, neat appearance of finish free from smudges and scratches by cleaning or repainting as required.

1.16 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect/Engineer seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
- D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of responsible manufacturer's representative in accordance with manufacturer's instructions.
- G. When specified in individual Specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

1.17 FACTORY START-UP AND START-UP REPORTS

- A. Provide factory start-up of mechanical equipment listed below. Factory start-up shall be performed by a factory authorized representative of the equipment manufacturer. When factory start-up is successfully completed for each piece of mechanical equipment listed below, submit a formal start-up report to the Architect for approval. Start-up report shall be formatted in accordance with equipment manufacturer's recommendations. Start-up report shall be typed, not hand written, and shall be submitted in a clean and legible form.
- B. Equipment requiring factory start-up
 1. Heat recovery unit
 2. Natural gas fired condensing boilers
 3. VRF heat recovery system(s)

1.18 ADJUSTMENTS AND OWNER'S INSTRUCTIONS

- A. After completion of the installation work called for in the Contract Documents, furnish necessary mechanics or engineers for the adjustment and operation of the systems, to the end that the systems are perfectly adjusted and turned over to the Owner in perfect working order. Further instruct the Owner's authorized representative in the care and operation of the installation, providing framed instruction charts, directions, and other related items.
- B. Instructors providing Owner training shall be experienced and familiar with the jobsite.
- C. Owner training sessions shall be video recorded on to digital media, with two copies of the recordings presented to the Owner at the end of training.

1.19 TESTING

- A. After the entire installation is completed and ready for operation, test the systems as outlined in Division 01 Section "Testing, Adjusting, and Balancing for HVAC." These tests are supplementary to detailed tests specified herein or directed. The Owner will provide water and electric current for the test. Provide necessary labor, test pump, gauges, meters, other instruments, and materials. Perform tests in the presence of the Architect or his representative.
- B. Perform other tests specified in individual Sections of this Specification.

1.20 COMPLETION OF SYSTEMS

- A. The following mechanical systems shall not be complete until the following conditions are satisfied:
 - 1. Ductwork Systems:
 - a. Ductwork and related components and accessories shall be completely installed and insulated as specified.
 - b. Ductwork leakage testing shall be completed and leakage testing reports shall be submitted and approved.
 - c. Ductwork shall be balanced and a balancing report shall be submitted and approved.
 - 2. Piping Systems:
 - a. Piping, valves and accessories shall be completely installed, insulated and labeled as specified.
 - b. Piping pressure testing be completed and pressure testing reports shall be submitted and approved.
 - c. Piping systems shall be balanced and a balancing report shall be submitted and approved.
 - 3. Equipment:
 - a. Equipment, including but not limited to boilers, terminal heat transfer units, pumps, air handling units, VRF heat recovery equipment, and exhaust fans, shall be completely installed.
 - b. Equipment start-up reports shall be completed, submitted and approved.
 - c. Equipment balancing shall be completed and the balancing report shall be submitted and approved.
 - 4. Automatic Temperature Controls (ATC):
 - a. ATC system shall be completely installed.
 - b. ATC system shall operate in an automatic mode for a minimum of four (4) months during Owner occupancy without substantial deficiencies.

1.21 OPERATING AND MAINTENANCE MANUALS

- A. Furnish 2 bound operating and maintenance manuals and forward to the Architect for review and transmittal to the Owner.
- B. For maintenance purposes, provide approved Submittals, parts lists, specifications, and manufacturer's maintenance bulletins for each piece of equipment. For materials used which have been submitted to the Architect for approval but do not require regular maintenance, such as piping, ductwork, and insulation, provide one copy of approved Submittals.
- C. Provide name, address and telephone number of the manufacturer's representative and service company, for each piece of equipment or material so that service or spare parts can be readily obtained.

1.22 WARRANTY

- A. Provide guarantees and warranties for work under this Contract as indicated in the general requirements of the Contract.
- B. Provide manufacturers' standard warranties and guarantees for work by the mechanical trades. However, such warranties and guarantees shall be in addition to and not in lieu of other liabilities which the manufacturer and the Mechanical Contractor may have by law or by other provisions of the Contract Documents.
- C. Guarantee that elements of the systems provided under this Contract are of sufficient capacity to meet the specified performance requirements as set forth in these Specifications or as indicated on the Drawings.
- D. Upon receipt of notice from the Owner of failure of any part of the mechanical systems or equipment during the warranty period, the Mechanical Subcontractor shall replace the affected part or parts.
- E. Furnish a written guarantee covering the above requirements before submitting the application for final payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230500

SECTION 230513 – MOTORS, DRIVES, AND ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Common requirements for electric motors furnished on equipment specified in other Sections, including single phase and three phase electric motors.
- B. Shaft Grounding Rings
- C. Starters.
- D. Thermal Overload Protection.
- E. Belt Drives.
- F. Variable Speed Drives.

1.2 REFERENCES

- A. Division 01 for requirements for references and standards.
- B. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- C. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- D. NEMA MG 1 - Motors and Generators.
- E. NFPA 70 - National Electrical Code.
- F. UL 674 - UL Standard for Safety Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
- G. UL 1836 - UL Standard for Safety for Electric Motors for Use in Class I, Division 2 and Class II, Division 2 Hazardous (Classified) Locations.

1.3 REGULATORY REQUIREMENTS

- A. Conform to UL Component Recognition for appropriate sizes.
- B. Conform to NFPA 70 and local energy code.

1.4 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01 for transport, handle, store, and protect products.

- B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Acceptable Manufacturers:
 - 1. A.O. Smith.
 - 2. Baldor.
 - 3. Emerson Motor Technologies.
 - 4. General Electric.
 - 5. Greenheck Fan Corporation.
 - 6. Marathon Electric.
 - 7. Siemens.
 - 8. Teco-Westinghouse.
 - 9. Toshiba.
 - 10. U.S. Motors (division of Emerson Motor Technologies).
- B. General Construction and Requirements:
 - 1. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these specifications.
 - 2. Motors shall have integral thermal overload protection.
 - 3. Single Phase Motors for general applications: PSC (permanent split capacitor) where available.
 - 4. Single Phase Motors for fans:
 - a. EC (electronically commutated) where available.
 - b. PSC (permanent split capacitor) where available, if EC is not available.
 - 5. Open drip-proof type except where specifically noted otherwise.
 - 6. Design for continuous operation in 40 degrees C environment.
 - 7. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 8. Explosion-Proof Motors: UL approved for hazard classification.
 - 9. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency.
- C. Inverter Duty: Motors for use with variable frequency drives shall be rated for A_{inverter} duty@, with winding insulation rated for 1600 volts and Class H (180°C) temperature rating.
- D. Single-Phase Power for Fans - Electronically-Commutated (EC) Motors - Also Known As Brush-Free DC (BFDC) Motors:
 - 1. Drive: Direct-drive only, not for use with belt drive.
 - 2. Power Supply: Internal motor circuitry shall convert AC power supplied to DC power to operate the motor.
 - 3. Turndown: Speed-controllable down to 20% of full speed (80% turndown).

4. Speed Control: Integral potentiometer with screwdriver setting, remote potentiometer dial with 24 VDC transformer to generate a 0-10 VDC signal, or integral circuitry to accept a 0-10 VDC signal from the building control system, as indicated and specified.
 5. Efficiency: Minimum of 85% efficient at all speeds.
 6. Soft-start type, capable of reliable start at any speed setting.
 7. Enclosure: Open drip-proof.
 8. Bearings: Permanently lubricated heavy duty ball bearings.
 9. Overload Protection:
 - a. Automatic Speed Control: In the event of overheating or overloading, the motor electronics slow the motor to operate within its acceptable range.
 - b. Thermal Overload: Internally fused, one-shot type as a last resort to prevent fires.
 - c. Locked Rotor: If the motor sees a locked rotor condition, it will automatically shut itself down, then try to restart 3 times. After the 3rd try, the motor will not attempt to restart until the power is cycled.
- E. Single Phase Power - Permanent-split Capacitor Motors:
1. Starting Torque: Exceeding one fourth of full load torque.
 2. Starting Current: Up to six times full load current.
 3. Multiple Speed: Through tapped windings.
 4. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.
- F. Single Phase Power - Capacitor Start Motors:
1. Starting Torque: Three times full load torque.
 2. Starting Current: Less than five times full load current.
 3. Pull-up Torque: Up to 350 percent of full load torque.
 4. Breakdown Torque: Approximately 250 percent of full load torque.
 5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
 6. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated bearings.
 7. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- G. Single Phase Power - Split Phase Motors:
1. Starting Torque: Less than 150 percent of full load torque.
 2. Starting Current: Up to seven times full load current.
 3. Breakdown Torque: Approximately 200 percent of full load torque.
 4. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
 5. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- H. Three Phase Power - Squirrel-cage Motors:
1. Starting Torque: Between 1 and 1-1/2 times full load torque.
 2. Starting Current: Six times full load current.
 3. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B energy-efficient motors.
5. Insulation System: NEMA Class B or better.
6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
8. Sound Power Levels: To NEMA MG 1.
9. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
10. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
11. Nominal Efficiency: To NEMA MG 1, energy efficient for motor sizes 10 and larger.

2.2 SHAFT GROUNDING RINGS

- A. Manufacturers:
 1. Electro Static Technology Inc. - Aegis SGR product line.
 2. Inpro/Seal, a division of Waukesha Bearings Corporation - CDR product line.
- B. Provide shaft grounding rings (SGRs) on 3-phase motors 5 hp (3.7 kW) or larger which are intended to be used with variable-frequency drives (VFDs). The SGRs may be furnished by the motor manufacturer as an integral part of the motor, furnished factory-installed by the equipment manufacturer, or furnished for field installation by the equipment installer.
- C. Description: Circumferential micro-fiber ring with metal frame, designed to conduct VFD-induced bearing currents from the motor shaft to ground. Provides protection recommended in NEMA MG 1. Provide with mounting kit including bolts and bracket, or conductive epoxy to adhere to motor casing, to ensure ground connection from the SGR to the motor frame.
- D. Provide SGRs on at least one end of the motor. On motors above 100 hp (74.5 kW), provide a bearing insulation kit on the end of the motor without an SGR.

2.3 STARTERS AND OVERLOADS

- A. Acceptable Manufacturers:
 1. Siemens.
 2. Allen-Bradley (division of Rockwell Automation).
 3. Cerus Industrial, Inc.
 4. Cutler Hammer (division of Eaton Corporation).
 5. General Electric.
 6. Square D (division of Schneider Electric).
- B. Motor starters shall be furnished for motors provided under this Section of these specifications. Each 3 phase motor starter shall have a 3-pole type, three element overload device and shall have "ON-AUTO-OFF" switch in cover plate. They shall be general purpose NEMA rated for connected H.P. (definite purpose starters not acceptable) and shall have control power with

fused transformers as required. Coordinate control voltage with Controls Contractor. Provide auxiliary contacts where required for interlocking of electrical equipment. Provide two-speed motor starters where indicated.

1. Single phase motors shall have one of the following factory wired methods of motor protection:
 - a. Integral thermal overload protection in motor and cord with plug and receptacle in unit casing.
 - b. Integral thermal overload protection in motor and disconnecting switch mounted in or on casing as specified with equipment.
 - c. Switch with thermal overload protection for unprotected motors with switch serving as disconnect device.

- C. Thermal overload devices shall be sized for motor nameplate full load amps or field measured amp draw, whichever is less. Replace elements as required by field measurements.

- D. For starters associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the starter enclosure to interface with the building's fire alarm system. Upon receipt of a signal from the building's fire alarm system, power to load side of the starter shall be turned off. Circuitry shall be provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, provide a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements of division 16.

- E. At Contractor's option, Cerus Industrial "BAS" building automation HVAC starters may be provided. Features of starters/contactors, disconnects, and temperature controls may be combined in a single package using these starters. Coordination with Automatic Temperature Controls supplier and installer is recommended to reduce total project costs. Features include:
 1. Multi-tap control power transformer (CPT) for universal control voltage.
 2. Motor circuit protector disconnect (MCP) with high interrupt rating and lockable operator handle.
 3. Contactors rated as high as 2.5 million electrical operations and 25 million mechanical operations.
 4. Anti-cycling feature.
 5. Solid-state electronic overloads with wide adjustment range and highly accurate digital motor protection, including protection for phase loss, phase unbalance, stall and locked rotor conditions. Class 1-30.
 6. Digital keypad, featuring an H-O-A (Hand, Off , Auto) panel with large, clearly labeled push buttons including a front panel reset function and high-intensity LED indicators for settings.
 7. Damper and valve actuator control, to open the actuator before starting the fan or pump motor.
 8. Permissive auto control to disable auto inputs. Commonly used with a high pressure limit switch.
 9. Universal control inputs, including auto dry input, and wet input for voltages from 20 to 138 VAC or VDC.
 10. Power failure reset.
 11. Fireman's override.
 12. NEMA 1 enclosure with prepunched knockouts. NEMA 3R, 4, 4X, and 12 as required.
 13. BACnet embedded communications option available.
 14. UL Listed assembly.
 15. 5-year warranty.

2.4 V-BELT DRIVES

- A. Provide self-aligning roller-bearings mounted in sealed housings with grease fittings and grease overflow valves. Fan wheels and shafts shall be designed for critical speed at least 20% higher than the maximum fan speed. The assembled fan shall be statically and dynamically balanced at the factory. Bearings shall be certified to have an average life per AFBMA of not less than 200,000 hours.
- B. Provide adjustable belt drives for motors. Belts and pulleys shall be designed for a minimum 1.5 safety factor. The base shall be constructed to allow adjustment of belt tension without having to loosen motor hold-down bolts.

2.5 VARIABLE FREQUENCY DRIVES

- A. Acceptable Manufacturers:
 - 1. Cerus Industrial, Inc. (P-Series).
 - 2. Danfoss (VLT FC-100 Series).
 - 3. Rockwell Automation (Allen-Bradley).
 - 4. Toshiba (Q7 Series).
 - 5. Schneider Electric (S-Flex)
 - 6. No substitutions.
- B. The variable frequency drives (VFDs) with options shall be UL listed as a complete assembly and shall be built in compliance with the latest standards of ANSI, IEEE, NEMA and the National Electric Code.
- C. The VFDs shall be designed to meet the requirements of the following standards: IEC801-2, IEC801-4, IEC255-4.
- D. Quality Assurance:
 - 1. Manufacturer: Shall specialize in manufacture, assembly, and field performance of VFDs with minimum 5 years' experience.
 - 2. The VFD manufacturer shall have an existing representative, exclusively for HVAC applications, an independent service and start-up organization, and a parts stocking depot local to the installation.
- E. Warranty and Start-Up Service:
 - 1. Start-Up Service: The VFD manufacturer shall provide a start-up service package. Service shall include inspection, final adjustment, operational checks, coordination with interface to building's ATC system (coordinate with Division 23 Section "Instrumentation and Controls for HVAC") and a final report for record purpose. Start-up service shall be performed by a factory approved and certified technician.
 - 2. Report: Submit a report of start-up and initial settings and readings.
 - 3. Owner Training: Provide a session of at least 4 hours, to train 2 or more of the Owner's representatives in the operation and maintenance of the drives. Schedule the training at the Owner's convenience within normal working hours, within 2 months after Substantial Completion.
 - 4. Warranty: For a period of 2 years after factory start-up, the VFD manufacturer shall include a full parts and labor on-site warranty at no additional cost.

F. Construction:

1. Pulse Width Modulated design converting the fixed utility voltage and frequency to a variable voltage and frequency output. The VFD shall employ a full wave bridge rectifier, DC bus choke, DC bus filter capacitors, and Insulated Gate Bipolar Transistors (IGBTs) as the output switching device. SCRs, GTOs and Darlington transistors are not acceptable. The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
2. 6-pulse (minimum) converter section.
3. NEMA 1 ABS plastic or metal enclosure. Verify suitability of this enclosure for the application, and provide suitable enclosures either instead of or in addition to the basic enclosure.
4. Standard operating conditions are:
 - a. Incoming AC power at building power system design's phase and voltage (see Contract Drawings) ± 10 percent, 60 Hz. Output voltage, phase and frequencies compatible with equipment served (see Contract Drawings).
 - b. Humidity 0 to 95 percent (noncondensing and noncorrosive).
 - c. Altitude 0 to 3,300 feet above sea level, without derating.
 - d. Ambient temperature 0 to 40 degrees C.
 - e. Verify actual operating conditions, and derate drive capacity as required.
5. VFDs shall include the following features:
 - a. Customer interface, including digital display in plain English (code numbers are not acceptable), keypad and customer connections.
 - b. Carrier (Switching) Frequency: Optimized for a 3 kHz or 4 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up technician, in a range at least as low as 1 kHz and as high as 8 kHz. Provide at least the following settings to allow fine tuning: 1 kHz, 4 kHz, and 8 kHz.
 - c. Built-in program to automatically vary the carrier (switching) frequency. Acceptable types of control include:
 - 1) ABB's switching frequency foldback control, reduces heat generated by the IGBTs by reducing the carrier frequency if the heatsink temperature rises above 176-194 degrees F (80-90 degrees C).
 - 2) Danfoss automatic switching frequency modulation, reduces noise at low loads (below 60 percent) by adjusting the carrier frequency up to a selected maximum, and provides maximum power and efficiency at higher loads by adjusting the carrier frequency downward to a more efficient setting.
 - d. The option of either (1) displaying a fault, (2) running at a preset speed, or (3) running at the last known speed (average of last 10 seconds) if the input reference (4-20mA or 2-10V) is lost.
 - e. Automatic restart after an overcurrent, overvoltage, or undervoltage, or loss of input signal protective trip. The number of restart attempts and trial time shall be programmable.
 - f. The ability to start into a rotating load (forward or reverse) and accelerate or decelerate without safety tripping or component damage (flying start).
 - g. Automatic power loss ride through circuit that will utilize the inertia of the load to keep the drive powered. Minimum power loss ride through shall be 1 cycle based on full load and no inertia.
 - h. Isolated power for control circuits.
 - i. Input line fuses.
 - j. Acceptable start/stop commands shall include closure of a contact or switch, application and removal of input power and optional application and removal of 115 VAC on-off signal.

- k. Load loss detection. Each VFD shall provide a dry contact closure at a field adjustable load threshold to indicate a loss of motor load (for example, broken fan belt or pump cavitation).
 - l. Pilot light cluster to provide visual indication of protective functions and circuit status, including the following LEDs:
 - 1) Power on (Red): Illuminates when main power is applied to the controller.
 - 2) AFC Run (Green): Illuminates to annunciate a drive run condition.
 - 3) AFC Fault (Yellow): Illuminates to annunciate a fault condition.
 - m. Five programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.
 - n. PI setpoint controller integral to the drive, allowing a pressure or flow signal to be connected to the VFD, using the VFD for the closed loop control, eliminating the need for external controllers.
 - o. Three programmable digital relay outputs, rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS.
 - p. Seven programmable preset speeds.
 - q. Six programmable digital inputs for interface with energy management system.
 - r. Two independently adjustable acceleration and deceleration ramps, adjustable from 1 to 1800 seconds.
 - s. Ramp or coast to a stop.
 - t. Two programmable analog outputs to provide 4-20 ma signals linear to output frequency, motor speed, output current, motor torque, motor power, DC bus voltage, and motor voltage.
6. VFD door mounted operator digital display shall include:
- a. Output Frequency
 - b. Motor Speed (RPM)
 - c. Motor Current
 - d. Calculated Motor Torque
 - e. Calculated Motor Power
 - f. DC Bus Voltage
 - g. Output Voltage
 - h. Heat Sink Temperature
 - i. Analog Input Values
 - j. Keypad Reference Values
 - k. Elapsed Time Meter
7. VFD speed command input shall include:
- a. Keypad.
 - b. Two analog inputs, each capable of accepting a 0-20 mA, 4-20mA, 0-10V, and 2-10V signal inputs isolated from ground, and programmable via the keypad for different uses. Inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The input shall be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed.
 - c. Floating point input to accept a three wire input from a Dwyer Photohelic gauge or equivalent type instrument.
 - d. RS-485 communications.
8. The VFD shall include the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in plain words.
- a. Overcurrent trip, 200 percent of the VFD's variable torque current rating.
 - b. Overvoltage trip, 130 percent of the VFD's rated voltage.

- c. Undervoltage trip, 60 percent of the VFD's rated voltage.
 - d. Over temperature, + 70 degrees C.
 - e. Ground fault.
 - f. Adaptable Electronic Motor Overload Protection: Shall protect the motor based on speed, load curve, and external fan parameter. Circuits that protect the motor only at full speed are unacceptable.
 - g. Power line surge protection by means of a metal oxide varistor (m.o.v.).
9. Accessories to be furnished and mounted by the drive manufacturer and contained in a single enclosure (the use of more than one enclosure is not acceptable):
- a. Protection From Harmonics and Voltage Spikes: Provide one of the following:
 - 1) Line Reactors: 3-percent AC input line reactors to reduce harmonic current distortion to the incoming power line, and to provide some protection to the drive from incoming voltage spikes. Provide reactors in each phase of incoming power to each VFD. Install between the input power and the drive's input bridge rectifier (so they protect the rectifier). The line reactor shall provide attenuation of line side voltage transients, thus preventing overvoltage trips or other unnecessary VFD shutdowns and providing a reduction in harmonic current distortion. Line reactors shall be manufactured by TCI of Milwaukee, WI and must meet the following requirements: provide a minimum of 2-1/2 percent line impedance, have a saturation rating of no less than 2.5 times the continuous current rating, and be UL recognized.
 - 2) ABB Design: Integral 5 percent swinging chokes in the AC input lines, configured between the input power and the drive's input bridge rectifier (so they protect the rectifier from spikes in input power).
 - a) The swinging choke is an inductor with an inductance value inversely proportional to its operating current. Over a substantial portion of the normal operating current range, the inductance decreases as the current in the choke increases. A conventional or linear choke has a fixed inductance value that changes very little as the operating current varies in the normal operating range.
 - b) The harmonic limiting effectiveness of the swinging choke increases when the operating point is less than maximum power.
 - c) Compared to a standard linear choke, the swinging choke provides superior line harmonic current reduction when the drive's output power is less than or equal to rated output.
 - d) The effective inductance value of a swinging choke at full load is higher than the value of a linear choke of the same physical size.
 - e) The efficiency of a swinging choke is higher than the efficiency of a linear choke of the same inductance value.
 - f) Since the design point BHP is nearly always less than the nameplate horsepower of the selected motor, with swinging chokes the harmonic contribution of the drive will nearly always be less than that at maximum rated output power.
 - g) See U.S. Patent No. 6,774,758, "Low harmonic rectifier circuit" using non-linear inductor(s).
 - 3) Danfoss Design: Harmonic suppression and surge suppression integral to the drive using separate components.
 - a) Harmonic Suppression: DC link chokes (inductors) installed between the drive's input bridge rectifier and the inverter bus capacitor, consisting of a dual, 5 percent DC-link reactor on the positive and

negative rails of the DC bus. This reactor reduces the level of harmonics reflected back into the building power system without causing a voltage loss at the drive's input, and improves input power factor. The reactor is non-saturating (linear) to provide full harmonic filtering throughout the entire load range. In performance, the harmonic suppression of the DC-link reactor is equivalent to a 5 percent AC line reactor.

- b) Incoming Power-Line Surge Suppression: Fast-acting Metal Oxide Varistor (or (MOV) installed between the input power and the drive's input bridge rectifier, Zener diodes and oversized DC bus capacitors to provide protection against high potential spikes. When the voltage exceeds 2.3 times the expected incoming voltage for 1.3 milliseconds, the MOV shorts, protecting the internal parts of the drive including the 3-phase full-wave diode bridge. The reactor also acts to reduce input current caused by power line disturbances. Provide 4 MOVs, one on each of the 3 inputs and one attached to the DC Link. Comply with the German specification for surge suppression (VDE 0160).
- 4) Linear chokes or DC link chokes used alone without surge suppression on the incoming power are NOT acceptable as alternatives to line reactors. If they are standard and integral to the VFD, they may be provided in addition to line reactors.
- 5) Provide bypass on drives which serve single non-redundant motors, such as fan motors in air handling units and air conditioning units.
- 6) Bypass is not required on drives which serve one of a pair of matching and fully-redundant motors with individual drive per motor (such as a pair of pumps where one is the lead pump and one is a 100 percent backup, and each pump has its own VFD).
- b. Service switch which provides the ability to service the controller (electrically isolated while in bypass operation) without having to remove power to motor.
- c. Hand-off automatic switch (HOA), prewired. The HOA switch shall be operable in both the Normal and Bypass (if provided) modes of operation. The switch may be dial type, or momentary-contact pushbutton type with LED indicator lights. The switch may be integral to the standard VFD keypad, if it is a dedicated physical switch that is always available, but it is not allowed to serve any other functions, and it may not be a virtual switch such as on a touchscreen.
 - 1) When Auto mode is selected, the external start command and external reference speed signal shall control the motor.
 - 2) When Hand mode is selected, the motor shall run and the manual potentiometer shall control the motor speed. Other controls and inputs/outputs shall function as in Auto mode.
- d. Manual potentiometer, dial type with calibrated nameplate. Provide an analog (dial-type) or digital meter to indicate selected speed.
 - 1) If the HOA switch is a dedicated button integral to the VFD keypad, and the potentiometer function is immediately available without any further steps when the HOA is in "Hand" position (such as up-down pushbuttons on the face of the keypad), the potentiometer may be integral to the standard VFD keypad. The speed meter may be a display on the general display screen.
- e. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. External interlocks and start/stop contacts shall function with drive in hand, auto or bypass.
- f. Door interlocked disconnect or circuit breaker, padlockable in off position.

- g. For drives that control fans or pumps which are specified to operate in an automatic lead/lag arrangement, provide automatic alternation device in VFD enclosure. (coordinate with Division 23 Section “Instrumentation and Control for Mechanical Systems”).
 - h. Damper Control Interlock shall:
 - 1) Provide 110 VAC output to the damper EP relay upon receipt of a start command to the VFD.
 - 2) Provide input terminals for connection to damper end switch. VFD shall not start until damper end switch is closed.
 - 3) Damper control circuit shall be operable in Hand, Auto, and Bypass.
10. Energy Management System Interface
- a. Drive shall have the capability to be controlled and monitored via analog and digital inputs and outputs.
 - b. In addition to analog and digital I/O the VFD shall be capable of communicating with the following controls companies’ communication buses with no extra hardware:
 - 1) Johnson Controls
 - 2) Siemens Controls
 - c. Drive shall have integral capability to be controlled and monitored through BACnet, LonWorks, Modbus, or other serial communication protocol compatible with the building automatic temperature control system. Provide adapter modules as required.
 - d. Coordinate with suppliers and installers of building automatic temperature control system to ensure compatibility and full functionality. See Division 23 Section “Instrumentation and Controls for Mechanical Systems.”
11. In the event of a power failure and upon restoration of power, the variable frequency drive shall remain responsive to its command signal from the building’s energy management/temperature control system. The drive shall not require manual resetting after a power outage in order to respond to the energy management/temperature control system’s command signal.
12. For drives that are associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the VFD enclosure to interface with the building’s fire alarm system. Upon receipt of a signal from the building’s fire alarm system, power to load side of the VFD shall be turned off. Circuitry shall be provided to ensure that power is off whether the VFD is in the “AUTO”, “HAND” or “BYPASS” mode. If this feature is not available from the VFD manufacturer, provide a contactor on the line side of the VFD to accomplish the same function. The contactor shall meet the requirements of the Electrical Division of the Specifications.
13. Occasional input and output power circuit switching shall be able to be accomplished without interlocks or damage to the drive. If drive design cannot tolerate interruption of output, such as by a disconnect switch mounted between the drive and the motor, provide protective devices and coordinate with installers to protect the drive as specified in Part 3 – Execution in this Section.

G. Compliance with IEEE-519:

- 1. Input Line Reactors: Provide as specified in “Construction” paragraph of this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Division 01 for Quality Requirements”: Manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and direction of rotation, and ensure agreement with nameplate.
- D. Install guards in accordance with Codes and OSHA requirements.
- E. Variable Frequency Drives:
 - 1. Mounting Height:
 - a. Install with the disconnect switch height in accordance with NFPA 70, as described in the paragraph “Disconnect Switch Mounting Height” in this Section.
 - b. The VFD shall be considered to be a piece of equipment served by its disconnect switch, for purposes of NFPA 70, unless otherwise indicated, or otherwise directed by the Authority Having Jurisdiction or by the Owner.
 - 1) If the motor served by the VFD is within sight of the VFD, and within 50 feet (15.2 m) measured in a straight line, this disconnect switch may also serve the motor unless otherwise indicated.
 - c. When possible, install VFDs with their operator-interface display at 79 inches (2.0 m) or less above finished floor, unless otherwise indicated or directed.
 - 1) To restrict unauthorized access, VFDs in locations accessible to the public (such as but not limited to classrooms, unrestricted storage rooms, and corridors) shall be mounted with the disconnect switch at 72 to 79 inches (1.8 to 2.0 m) above finished floor, with the VFD operator display and other accessories mounted above the disconnect switch, where ceiling height allows, unless otherwise indicated.
 - 2) In mechanical rooms and other restricted-access locations, mount VFDs at a height for greatest user convenience.
 - d. When possible, mount groups of adjacent VFDs with tops at uniform height above finished floor.
 - e. Because VFDs produce heat, do not install a VFD above another one, or above another heat-producing device. Do not install a VFD below or too near to any heat-sensitive device or room temperature sensor. Provide ventilation space and other means of cooling as required by the manufacturer.
 - f. Install with service and installation clearances as required by the manufacturer.
 - 2. Electrical Connections:
 - a. Provide separate metal conduits for drive input power, output power to the motor, and control wiring. Output motor cables from multiple drives shall be run separately.
 - b. Ground each drive separately.
 - c. Ensure that a fused disconnect switch is provided upstream between the transformer and the drive. Fuses are required because they are faster-acting than circuit breakers.

- d. If drive design cannot tolerate interruption of output, such as by a disconnect switch mounted between the drive and the motor, provide protective devices and coordinate with installers to protect the drive, and coordinate with installers to ensure that no unnecessary switching is installed.
 - 1) When the VFD is out of sight from the equipment served, or is more than 50 feet (15.2 m) from the equipment served, a disconnect switch mounted on or adjacent to the equipment is generally required in Division 26 “Electrical” or by the Authority Having Jurisdiction. If such a disconnect or other switching device is indicated or required, provide protective devices as required by the VFD manufacturer. Such devices typically include an “early-break” auxiliary set of contacts or a “Stop” button on the disconnect switch, field-wired to the VFD’s external fault input or stop input, so that if the switch is opened while the VFD is running, the input will shut off the output of the VFD. The VFD stop method must be set to “Coast.” Provide field wiring in conduit.
 - 2) Provide engraved nameplates at disconnect switches and other devices, instructing users on the proper operation of these devices to prevent damage to the VFD.
3. Carrier Frequency: Adjust to minimize noise, but also to minimize the potential for motor bearing damage due to VFD-induced shaft voltage.
 - a. VFDs convert line AC voltage to a pulse width modulated (PWM) AC voltage of variable frequency. The switching frequency of these pulses is referred to as the “carrier frequency.” The switching induces a voltage on the rotor shaft, which, if it builds up to a sufficient level, can discharge as “bearing current” to ground through the bearings. This has an electric discharge machining (EDM) effect, causing pitting of the bearing’s rolling elements and raceways. This effect can be minimized by proper setup.
 - b. The higher the carrier frequency, the higher the rate of the current discharge pulses, and the more likely EDM will occur. At higher carrier frequencies the VFD will generally run quieter; however, it becomes more destructive on the motor insulation and bearings.
 - c. Adjust the carrier frequency as low as possible without creating unacceptable audible noise levels, and to avoid frequencies above 6 kHz altogether if possible.
4. Coordinate with building controls systems as specified in Part 2 of this Section.
5. Perform startup service, and submit report.
6. Provide warranty service.
7. Provide Owner training.

END OF SECTION 230513

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SECTION 230516 – EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Pipe anchors and alignment guides.
- C. Pre-fabricated flexible expansion loops.

1.2 RELATED SECTIONS

- A. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”
- B. Division 23 Section “Hydronic Piping.”
- C. Division 23 Section “Hydronic Specialties.”
- D. Division 23 Section “Refrigerant Piping.”

1.3 REFERENCES

- A. MIL-E-17814E - Expansion Joints, Pipe, Slip-Type, Packed.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion loops provided adequately protect system.
- B. Expansion Calculations:
 - 1. Installation Temperature: 50 degrees F (10 degrees C).
 - 2. Hot Water Heating: 210 degrees F (99 degrees C).
 - 3. Low-temperature Water Heating: 110 degrees F (43 degrees C).
 - 4. Safety Factory: 30 percent.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- C. Design Data: Indicate selection calculations.

- D. Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Project Record Documents."
- B. Record actual locations of flexible pipe connectors, expansion loops, anchors, and guides.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."
- B. Maintenance Data: Include adjustment instructions.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.
- B. Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the place where the project is located.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Accept expansion loops on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
- C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

- A. Provide warranty under provisions of Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 DOUBLE-SPHERE FLEXIBLE PIPE CONNECTORS

- A. Application: Provide Double-Sphere type wherever flexible connectors are indicated or specified, except in locations where other types are specifically detailed or specified.
- B. Piping 3/4 inch to 1-1/2 inch (19 mm to 38 mm):
 - 1. Manufacturers:
 - a. Metraflex.
 - b. American Wheatley.
 - c. Flex-Hose Co.

- d. Mason Industries - see “Single-Sphere Flexible Pipe Connectors”.
 - e. Proco Products, Inc.
 - f. Twin City Hose, Inc.
2. Hose: Neoprene inner and outer with nylon tire cord fabric reinforcing.
 3. Control Cables: Provide if recommended by Manufacturer, with installed length slack at neutral installation to prevent vibration transmission. Cable shall be taut only when the connector exceeds maximum allowable extension.
 4. Pressure Rating: 150 psig (1035 kPa) WOG and 220 degrees F (104 degrees C), at 70 degrees F (21 degrees C) room temperature. Vacuum rating 16 in. Hg (54 kPa).
 5. Joint: Galvanized steel female unions.
 6. Size: Use pipe sized units.
 7. Allowable Movements: 0.87 inch (22 mm) axial compression, 0.23 inch (6 mm) axial elongation, 0.87 inch (22 mm) transverse movement on each side of installed center line, 17.5 degrees angular movement.
- C. Piping 2 inch to 12 inch (50 mm to 304 mm):
1. Manufacturers:
 - a. Mason Industries.
 - b. American Wheatley.
 - c. Flex-Hose Co.
 - d. Metraflex.
 - e. Proco Products, Inc. (up to 6 inch (75 mm) size).
 - f. Twin City Hose, Inc. (up to 6 inch (75 mm) size).
 2. Hose: Neoprene or EPDM inner and outer, with nylon or Kevlar tire cord fabric reinforcing.
 3. Control Cables: Provide if recommended by Manufacturer, with installed length slack at neutral installation to prevent vibration transmission. Cable shall be taut only when the connector exceeds maximum allowable extension.
 4. Pressure Rating: 150 psig (1035 kPa) WOG and 220 degrees F (104 degrees C), at 70 degrees F (21 degrees C) room temperature. Vacuum rating 16 in. Hg (54 kPa).
 5. Joint: 150 psig (1035 kPa) floating flanges; ductile iron with baked enamel finish, or steel.
 6. Size: Use pipe sized unit.
 7. Allowable Movements, 2 inch (50 mm) to 2-1/2 inch (63 mm) Size: 3/4 inch (19 mm) axial compression, 5/8 inch (15 mm) axial elongation, 5/8 inch (15 mm) transverse movement on each side of installed center line, 27 degrees angular movement.
 8. Allowable Movements, 3 inch (75 mm) Size and Up: 1-1/8 inch (28 mm) axial compression, 7/8 inch (22 mm) axial elongation, 7/8 inch (22 mm) transverse movement on each side of installed center line, 20 degrees angular movement.

2.2 SINGLE-SPHERE FLEXIBLE PIPE CONNECTORS

- A. Piping 3/4 inch to 1-1/2 inch (19 mm to 38 mm) (not allowed for larger piping):
1. Manufacturers:
 - a. Mason Industries.
 - b. No Substitutions.
 2. Hose: EPDM with Kevlar tire cord fabric reinforcing.
 3. Pressure Rating: 150 psig (1035 kPa) WOG and 220 degrees F (104 degrees C), at 70 degrees F (21 degrees C) room temperature. Vacuum rating 16 inch. Hg (54 kPa).
 4. Joint: Ductile iron floating flanges with baked enamel finish, with female threaded

- fittings for steel pipe, or sweat-end fittings for copper pipe.
5. Size: Provide pipe sized units.
 6. Allowable Movements: 3/4 inch (19 mm) axial compression, 3/8 inch (10 mm) axial elongation, 3/8 inch (10 mm) transverse movement on each side of installed center line, 22 degrees angular movement.
- B. Single-sphere connectors conforming with these specifications may be used where double-sphere type are indicated.

2.3 PRE-FABRICATED FLEXIBLE EXPANSION LOOPS

- A. Manufacturers:
1. Metraflex “METRALOOP”.
 2. Flex-Hose “TRI-FLEX LOOP”.
 3. Mason Industries “EQUI-V”.
 4. No substitutions.
- B. Provide flexible expansion loops of diameter and material consistent with the pipe system in which they are to be installed. Flexible loops shall be designed to impart no thrust loads on the anchors. At a minimum, the loop shall consist of 2 flexible sections of hose and braid, two 90 degree elbows, and a 180 degree turn. If Mason Industries “EQUI-V” connectors are used, the elbows shall be two 60 degree elbows and a 120 degree turn.
1. Joint: As specified for pipe joints.
 2. Size: Use pipe sized units.
 3. Nesting: Where nesting is indicated or required, provide extended lengths of the 180-degree turn as required.
 4. Shipping Bars: Remove after installation.
- C. Flexible Sections in Steel Piping:
1. Inner Hose: Stainless Steel.
 2. Exterior Sleeve: Double braided stainless steel.
 3. Pressure Rating: 200 psig (1380 kPa) WOG and 250 degrees F (121 degrees C), at 70 degrees F (21 degrees C) room temperature.
- D. Flexible Sections in Copper Piping:
1. Inner Hose: Bronze.
 2. Exterior Sleeve: Braided bronze.
 3. Pressure Rating: 200 psig (1380 kPa) WOG and 250 degrees F (121 degrees C), at 70 degrees F (21 degrees C) room temperature.

2.4 FLEXIBLE HOSE ASSEMBLIES

- A. If a piping connection is indicated or specified as a “flexible connection”, this Section applies.
- B. For flexible hoses such as “heat pump hoses” which may be indicated at items of equipment including water-source heat pumps, fan-coil units, and chilled beams, see Division 23 Section “Hydronic Specialties.”

2.5 ACCESSORIES

- A. Pipe Alignment Guides:
 - 1. Manufacturers:
 - a. Metraflex.
 - b. Hyspan.
 - c. Flexonics.
 - d. Carpenter & Paterson.
 - 2. 2-piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with 4 mounting holes, clearance for minimum 1 inch (25 mm) thick insulation, minimum 3 inch (75 mm) travel.
- B. Pipe Anchors:
 - 1. Manufacturers:
 - a. Metraflex.
 - b. Hyspan.
 - c. Flexonics.
 - d. Carpenter & Paterson.
 - 2. Provide structural I-Beam anchors equal to METRAFLEX PAI series, sizes as required.
- C. Provide miscellaneous steel for anchors and guides.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Construct spool pieces to exact size of flexible connection for future insertion.
- C. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation and on pipes connected to base mounted pumps, chillers, air handling units, unit ventilators, fan coil units and as indicated. Provide line size flexible connectors.
- D. Install flexible connectors at right angles to displacement (generally parallel to fan or pump shaft). Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- E. Rigidly anchor pipe to building structure. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints where indicated.
- G. Where flexible grooved couplings are indicated instead of flexible connectors at pumps and other equipment, provide minimum 1 flexible joint per inch (25 mm) pipe diameter. Grooved piping does not require anchoring at equipment. Submit coupling manufacturer's design recommendations for quantity and location of flexible couplings at each location.

- H. Provide expansion loops as indicated on Drawings.
- I. Pre-fabricated flexible expansion loops shall be installed in a neutral, pre-compressed, or pre-extended condition as required for the application. Loops installed hanging down shall have a drain plug. Loops shall not be installed straight up or at any angle above the horizontal plane, but in the event that the Architect's approval is given to install loops above the horizontal plane, loops shall be fitted with an automatic air release valve to purge air from the high point of the loop. Loops installed in any position other than hanging down shall have the 180 degree return supported. Install pre-fabricated flexible expansion loop within 4 pipe diameters, both upstream and downstream, from a pipe guide or anchor.
 - 1. Guides and Anchors: The Mechanical Contractors Association of America "Guidelines for Quality Piping Installations" section 3 - Pipe Hangers and Supports recommends guides on both sides of the expansion loops. Although some loop manufacturers say their loops don't require guides, it is required to provide guides as indicated and as specified. The intent is to direct pipe movement and to reduce stress on hangers.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Division 01 Section "Quality Requirements."
- B. Provide inspection services by flexible pipe manufacturer's representative for final installing. Certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 230516

SECTION 230519 – METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pressure gauges and Pressure gauge taps.
- B. Filter gauges.
- C. Test Plugs.
- D. Thermometers and thermometer wells.
- E. Thermowell heat transfer paste.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

1.3 SUBMITTALS

- A. Division 01 Section "Submittal Procedures": Procedures for submittals.
- B. Product Data: Provide manufacturers data and list which indicates use, operating range, total range, accuracy, and location for manufactured components.

1.4 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Closeout Procedures."
- B. Project Record Documents: Record actual locations of components and instrumentation.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."
- B. Include instructions for calibrating instruments.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 Section "Product Requirements": Environmental conditions affecting products on site.
- B. Do not install instruments when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Weiss Series 4CTS
 - 2. Terice 600 Series.
 - 3. Marshalltown.
 - 4. Amtek.
 - 5. Dwyer.

- B. Gauges, Hot Water Heating and Chilled Water Systems: Weiss Series 4PG-1 industrial pressure gauge, dry non-filled type, with phosphor bronze bourdon tube, silver brazed connecting joints, brass socket, bushed stainless rotary movement, 1/4" NPT connection, white aluminum dial with black markings, black aluminum pointer with front slotted adjustment..
 - 1. Case: Cast aluminum or stainless steel.
 - 2. Lens: Push-in Lexan polycarbonate, or clear glass or acrylic with stainless steel ring, per manufacturer's standard.
 - 3. Bourdon Tube: Phosphor bronze.
 - 4. Dial Size: 4 to 4-1/2 inch.
 - 5. Connection: Lower or lower back, 1/4" or 1/2" NPT, as selected by Contractor.
 - 6. Accuracy: 1 percent of full scale range, per ANSI-ASME B40.1 Grade 1A.
 - 7. Scale: Psi.
 - 8. Range: 0-60 psig typical, select for application.

- C. Verify suitability of range for each application. Best selection is for typical reading to be close to mid-scale.

2.2 PRESSURE GAUGE TAPPINGS

- A. Ball Valve:
 - 1. Manufacturers:
 - a. Weiss.
 - b. Terice.
 - c. Marshalltown.
 - d. Amtek.
 - e. Dwyer.
 - 2. Brass, 1/4 inch NPT for minimum 300 psi.
 - 3. Ball valves may also be furnished under applicable sections of the Specifications.

2.3 STATIC PRESSURE GAUGES

- A. Dial Gauges:
 - 1. Manufacturers:
 - a. Dwyer.
 - b. Terice.
 - c. Marshalltown.
 - d. Amtek.
 - 2. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

- B. Inclined Manometer:
 - 1. Manufacturers:
 - a. Dwyer.
 - b. Trerice.
 - c. Marshalltown.
 - d. Amtek.
 - 2. Plastic with red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

2.4 TEST PLUGS

- A. Test Plug:
 - 1. Manufacturers:
 - a. Peterson Equipment Co., Inc., "Pete's Plugs". www.petesplug.com
 - b. Weiss. www.weissinstruments.com
 - c. Flow Design, Inc. www.flowdesign.com
 - d. Trerice. www.trerice.com
 - 2. 1/2 inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with self-closing valves as follows:
 - a. Nordel (EPDM) core for water and hydronic heating and cooling service, temperatures range 30 to 275°F.
 - b. Neoprene core for natural gas or LP gas service, temperature range -40 to 150°F.
 - c. Verify core suitability for other fluids and temperatures.
 - 3. Working Pressure: 500 psig
 - 4. Cap Retaining Strap: Color coded to indicate core material.
 - 5. Construction with either dual self-closing valves (Pete's Plug standard design) or single valve are allowed.
 - 6. For chilled water applications, provide "XL" plugs which include a 1-1/2" extension for insulated piping.

2.5 THERMOMETERS - DIAL

- A. Manufacturers:
 - 1. Weiss.
 - 2. Trerice.
 - 3. Amtek.
 - 4. Ernst.
- B. Thermometer: Weiss Model 45VA, ASTM E1, stainless steel or cast aluminum case, adjustable angle with front recalibration, vapor actuated, black scale on white-finished metal background, black pointer, sealed lens, brass stem.
 - 1. Size: 4 to 4-1/2 inch dial.
 - 2. Lens: Snap-in Lexan polycarbonate with o-ring, or clear glass with rubber ring.
 - 3. Bulb: Copper. Provide extended bulb for socket extension in insulated pipe.
 - 4. Extended Bulb: Where required, provide extended capillary tube with braided copper protection.
 - 5. Connection: Separable socket.

6. Accuracy: 1 scale division throughout range.
7. Calibration: Degrees F.
8. Scale Range: 0 to 100°F for plumbing cold water, chilled water, and cooling tower/condenser water systems; 30 to 240°F for plumbing hot water, hot water heating, and supply air systems.
9. Graduations: 2°F.
10. Air Duct Flange: Provide for duct applications.

C. Provide dial type except where digital type is indicated.

2.6 THERMOMETER SUPPORTS

A. Socket (Thermometer Well) for Piping: Brass separable sockets for thermometer stems, with extensions for insulated piping. Provide with Honeywell viscous heat transfer paste.

2.7 THERMOWELL HEAT TRANSFER PASTE

A. Manufacturers:

1. MG Chemicals.
2. Honeywell.
3. Terice.

B. Description:

1. Formulation: Silicone or synthetic base, containing metal oxides.
2. Thermal Conductivity: At least 4.5 Btu-in.
3. Temperature Range: To 392°F.
4. Flash Point: 500°F.
5. Dropping Point: ASTM D566, greater than 500°F.
6. Specific Gravity: 2.3 minimum at 77°F.
7. Consistency: ASTM D217, 310 to 320.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use ball valves for water service.
- B. Division 01 - Quality Requirements: Manufacturer's instructions.
- C. Install one pressure gauge per pump, with taps on suction and discharge of pump; pipe to gauge.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Install thermometers in air duct systems on flanges.
- F. Fill thermometer sockets with heat transfer paste.
- G. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.

- H. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- I. Coil and conceal excess capillary on remote element instruments.
- J. Install static pressure gauges to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gauge.
- K. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- L. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- M. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- N. Locate test plugs where indicated.
- O. Provide pressure gauge at high point of system for setting of cold water make-up pressure reducing valve.
- P. Provide pressure gauge at connection to bladder type expansion tank for setting of air side pre-charge pressure.

END OF SECTION 230519

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SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and equipment hangers and supports.
- B. Equipment supports.
- C. Sleeves and seals.

1.2 RELATED SECTIONS

- A. Division 03 Section “Cast-In-Place Concrete”: Equipment bases.
- B. Division 07 Section “Through-Penetration Firestop Systems”: Joint seals for piping and duct penetration of fire rated assemblies.
- C. Division 23 Section “HVAC Piping Insulation.”
- D. Division 23 Section “Hydronic Piping.”

1.3 REFERENCES

- A. ASME B31.5 - Refrigeration Piping.
- B. ASME B31.9 - Building Services Piping.
- C. ASTM A653 G90 SS Gr. 33 - Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot Dipped Process.
- D. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- E. ASTM C642 - Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete.
- F. ASTM C672 - Test Methods for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
- G. ASTM D412 - Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
- H. ASTM D395 - Standard Test Methods for Rubber Property - Compression Set.
- I. ASTM D573 - Test Method for Rubber - Deterioration in an Air Oven.
- J. ASTM D746 - Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
- K. ASTM D2240 - Test Method for Rubber Property - Durometer Hardness.

- L. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- M. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- N. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- O. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- P. NFPA 13 - Installation of Sprinkler Systems.
- Q. NFPA 14 - Installation of Standpipe and Hose Systems.
- R. NFPA 70 B National Electrical Code
- S. UL 203 - Pipe Hanger Equipment for Fire Protection Service.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures”.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data: Provide manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable code for support of hydronic piping.
- B. Supports for Electrical: In conformance with NFPA 70.

PART 2 - PRODUCTS

2.1 HANGERS, SUPPORTS, & PIPE CLAMPS

- A. Approved Manufacturers (first manufacturer is basis of design):
 - 1. Strut Hangers:
 - a. Unistrut (division of Tyco).
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Hydra-Zorb Company.
 - e. Thomas & Betts - Superstrut line.
 - f. Tolco (division of Nibco).
 - 2. Adjustable Swivel Band Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.

- c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 3. Clevis Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 4. J-Hangers:
 - a. Carpenter & Paterson.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).
 - e. Unistrut (division of Tyco).
 - 5. Cushion Clamps:
 - a. Hydra-Zorb Company.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).
 - e. Unistrut (division of Tyco).
 - 6. Insulated Pipe Couplings:
 - a. Klo-Shure Corporation.
 - b. Cooper B-Line - Armafix line.
 - 7. No substitutions.
- B. Horizontal Piping Supports: Provide struts for trapeze hangers for single or multiple pipes. Where individual piping runs are hung with individual hangers, adjustable swivel band hangers, clevis hangers, or j-hangers may be used.
- C. Strut hangers shall be standard 1-5/8 inch x 1-5/8 inch size.
- D. Pipe hanger rods and nuts shall be plated to match the hangers. Nuts shall be self-locking type, or provide double nuts tightened to lock together. Rods shall be threaded one end, or continuous threaded. Provide washers at each nut.
- E. Cushion Clamps for Un-insulated Lines: Plastic cushion shall be Dupont Hytel plastic, 5555HS plastic elastomer, warranted from -40 F to 275 F.
- F. Copper-plated hangers are plated for identification only. Traditional thin copper plating on steel substrate does not provide adequate protection from galvanic corrosion due to contact between dissimilar metals.
- 1. Where copper-plated supports are specified for use with copper piping, either copper plating or a copper-colored finish such as Cooper B-Line's Dura-Copper epoxy coating is acceptable. This is for identification, and does not protect dissimilar metals.
 - 2. Where copper piping is used with steel hangers and supports, provide protection from galvanic corrosion such as thick plastic or vinyl factory coating, or plastic-lined cushion clamps.
- G. For Insulated Lines Clamped to Strut: Insulated pipe coupling insert with the same thickness as the insulation. Protects insulation from crushing, and provides continuous insulation and vapor barrier thru the hanger or clamp. Klo-Shure product provides plastic pipe support and rigid outer band, for

field insulation into the coupling. Armafix product provides insulation with rigid outer band, for field insulation glued to the ends of the insert.

2.2 PIPE SUPPORTS

A. Hydronic Piping:

1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches (50 to 100 mm): Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 5 Inches (125 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches (76 mm): Cast iron hook.
9. Wall Support for Cold Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 Inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 5 Inches (125 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.3 INSERTS

A. Manufacturers:

1. Grinnell.
2. B-Line.

B. Inserts: Malleable iron case of 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.

2.4 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gauge (1.2 mm) thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gauge (1.2 mm) thick galvanized steel.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

- D. Sleeves for Round Ductwork: Galvanized steel.
- E. Sleeves for Rectangular Ductwork: Galvanized steel.
- F. Stuffing or Firestopping Insulation: Glass fiber type, non-combustible.
- G. Sealant: Acrylic.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 INSERTS

- A. Provide inserts for placement in concrete formwork.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as scheduled.
- B. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
- C. Place hangers within 12 inches (300 mm) of each horizontal elbow.
- D. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.

- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Refer to Division 09 Section "Painting". Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Do not support pipes from other pipes or equipment.
- M. Size pipe hangers to accommodate continuous piping insulation.

3.4 EQUIPMENT SUPPORTS

- A. Suspend air handling units from structure above. Provide and install spring isolators at each hanger.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.
- E. Do not support equipment from pipes or from other equipment.

3.5 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors 1 inch (25 mm) above finished floor level. Caulk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- E. Install chrome plated steel escutcheons at finished surfaces.

3.6 SCHEDULES

PIPE SIZE		HANGER ROD MAX. HANGER SPACING		DIAMETER	
Inches	(mm)	Feet	(m)	Inches	(mm)
Steel and Copper Piping					
1/2 to 1-1/4	12 to 32	6.5	2	3/8	9
1-1/2 to 2	38 to 50	10	3	3/8	9
2-1/2 to 3	62 to 75	10	3	1/2	13
4 to 6	100 to 150	10	3	5/8	15
8 to 12	200 to 300	14	4.25	7/8	22
14 and Over	350 and Over	20	6	1	25

END OF SECTION 230529

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SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Labels.
- D. Stencils.
- E. Pipe Markers.

1.2 SUBMITTALS

- A. Division 01 Section “Submittal Procedures.”
- B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer’s name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.

1.3 PROJECT RECORD DOCUMENTS

- A. Submit under Division 01 Section “Closeout Procedures.”
- B. Record actual locations of tagged valves; include valve tag numbers.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”
- B. Include valve tag chart.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Seton Identification Products.
 - 2. E.R. Perry Signs & Engraving.
 - 3. Brimar Industries, Inc., PipeMarker division.
 - 4. No substitutions.

- B. Plastic Nameplates: Laminated 3-layer plastic with beveled edges and engraved letters on contrasting background color, 1/16-inch thick. Letters shall be black on light backgrounds, or white on dark backgrounds, as applicable. Service temperature range -40 to 175°F; minimum application temperature for adhesive 50°F. Suitable for average outdoor lifespan of at least 2-3 years.
- C. Aluminum Nameplates: For higher temperature applications, and for outdoor applications when manufacturer does not recommend their plastic nameplates for use outdoors, provide aluminum nameplates, with integral anodized or painted surface color coating and natural aluminum engraved letters, 1/32-inch thick. Service temperature range -40 to 350°F; minimum application temperature for adhesive 50°F. Suitable for average outdoor lifespan of at least 2-3 years.
- D. Colors: Select background color as appropriate for the application. Color for general applications shall be white (except that aluminum nameplate standard color shall be black). Color for general warnings shall be red or yellow. Colors for fluid services shall comply with ASME A13.1-2007. Comply with ASME/ANSI standards and other regulations as applicable.
- E. Provide with factory adhesive, and with side holes for fastener attachment as applicable. Mechanical fasteners are required for applications which are outdoors or otherwise exposed to weather or sunlight, or in moist areas such as kitchens and locker rooms, or on cooled surfaces subject to condensation, or on surfaces with operating temperatures above 150°F. Where nameplate is on an irregular surface and cannot make complete contact, provide mechanical fasteners or ties in addition to adhesive.

2.2 TAGS

- A. Plastic Tags:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. E.R. Perry Signs & Engraving.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
 - 2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
- B. Metal Tags:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
 - 2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with smooth edges.
- C. Information Tags:
 - 1. Manufacturer: Seton Identification Products.
 - 2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- D. Tag Chains and Hooks: Brass or stainless steel compatible with tag material for general applications. Brass where in contact with copper piping or other copper-alloy materials.
- E. Tag Chart: Typewritten letter size list in anodized aluminum frame with plexiglass cover.

2.3 LABELS

- A. Manufacturer: Seton Identification Products.
- B. Description: Polyester, size 1.9 x 0.75 inches, adhesive backed with printed identification.

2.4 STENCILS

- A. Manufacturers:
 - 1. Seton Identification Products.
 - 2. Brimar Industries, Inc., PipeMarker division.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inch Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
 - 2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1 inch high letters.
 - 3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
 - 4. Ductwork and Equipment: 1-3/4 inches high letters.
- C. Stencil Paint: Semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.5 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
 - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Division 01 Section "Quality Requirements": Manufacturer's instructions.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic or aluminum engraved nameplates with corrosion-resistant mechanical fasteners, or adhesive, as specified. In outdoor locations, where lifetime of nameplates is limited, fasteners shall be removable screws or bolts for ease of nameplate replacement.

- D. Install labels with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain. Number tags consecutively by location.
- F. Identify items of mechanical equipment such as chillers, fans, terminal units, 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 tags.
- G. Identify control panels and major control components outside panels with plastic nameplates.
- H. Identify valves in main and branch piping with metal tags.
- I. Tag automatic controls, instruments, and relays. Key to control schematic.
- J. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. 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, at each branch and riser take-off, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- K. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- L. Identify duct access doors at fire dampers, smoke dampers, and smoke detectors with 1/2-inch lettering to indicate the fire protection device(s) within, in accordance with NFPA 90A.
- M. Secure valve tag chart on an easily accessible wall in the mechanical room or in a location as otherwise directed by the Architect.

END OF SECTION 230553

SECTION 230713 – DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Duct Liner.
- C. Fire Resistive Duct Wrap for Kitchen Grease Exhaust.

1.2 SUBMITTALS

- A. Division 01 Section “Submittal Procedures”.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.
- B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.4 REGULATORY REQUIREMENTS

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches.
- B. Insulation materials shall be asbestos free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01 Section “Product Requirements”: Transport, handle, store, and protect products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 Section “Product Requirements”: Environmental conditions affecting products on site.

- B. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- C. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Glass and Mineral Fiber Products:
 - 1. Knauf Insulation.
 - 2. Certainteed Corporation.
 - 3. Johns Manville.
 - 4. Owens Corning.
 - 5. No substitutions.
- B. Polyimide Foam Duct Liner:
 - 1. Evonik Foams Inc., Solcoustic duct liner.
 - 2. No substitutions.
- C. Fire-resistive Duct Blankets for Kitchen Grease Exhaust:
 - 1. 3M Company – Fire Barrier Duct Wrap 615+.
 - 2. Thermal Ceramics Inc. – FireMaster FastWrap XL.
 - 3. Unifrax Corporation – FyreWrap Elite 1.5.
 - 4. No substitutions.
- D. Glass Fiber Insulation Sealing Tapes:
 - 1. Venture Tape Corporation.
 - 2. 3M Company.
 - 3. Ideal Tape Co., division of American Biltrite Inc.
 - 4. Nashua Tape Products, division of Berry Plastics Corp.
 - 5. No substitutions.
- E. Accessories:
 - 1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
 - 2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
 - 3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket systems).
 - 4. Pabco/Childers Metals, division of ITW Insulation Systems (products: metal jacket systems, and accessories).
 - 5. Vac Systems International (product: Tough Coat acrylic polymer mechanical insulation repair coating).
 - 6. Venture Tape Corporation (product: Jacket for outdoor insulation).

2.2 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. 'K' ('Ksi') value: ASTM C518, 0.27 at 75°F.

2. Maximum service temperature: 250°F faced and 350°F unfaced.
 3. Maximum moisture absorption: 0.20 percent by volume.
 4. Minimum density: 1.0 lb/cu.ft.
- B. Vapor Barrier Jacket:
1. ASTM C1136, Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier film. Facing as required for the application. Integral staple flap on one edge.
 - a. Aluminum Faced: FSK (aluminum foil-scrim-kraft) construction.
 - b. White Faced: PSK (polypropylene-scrim-kraft) construction.
 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 3. Suitable for insulation surface temperatures up to 150°F.
 4. Overlap longitudinal laps and butt strips.
 5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.
- C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.
- D. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- E. Tie Wire: Annealed steel, 16 gage.

2.3 GLASS FIBER, RIGID

- A. Insulation: ASTM C612; rigid, noncombustible blanket. Supplied in board form.
1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75°F.
 2. Maximum service temperature: 450°F.
 3. Maximum moisture absorption: 1.0 percent by volume.
 4. Density: 3.0 lb/cu ft.
- B. Vapor Barrier Jacket:
1. ASTM C1136, kraft paper reinforced with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
 - a. Aluminum Faced: FSK (foil-scrim-kraft) construction
 - b. White Faced: ASJ (all-service jacket) construction.
 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 3. Suitable for insulation surface temperatures up to 150°F.
 4. Overlap longitudinal laps and butt strips.
 5. Secure insulation with mechanical fasteners to substrate, and seal jacket with pressure sensitive tape.
- C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.
- D. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.4 POLYIMIDE FOAM DUCT LINER

- A. Insulation: ASTM C1482; flexible cellular polyimide foam, formaldehyde-free, sheet form, factory-treated with acrylic polymer impregnated surface and edge coat meeting ASTM G21 containing an immobilized EPA-registered preservative to inhibit biological growth.
1. 'K' ('Ksi') value: ASTM C518; 0.30 Btu-in/(h-ft²-degrees F) at 75 degrees F (0.049 W/m-K at 24 degrees C).
 2. Maximum service temperature: ASTM C411; 250 degrees F (121 degrees C).
 3. Maximum moisture absorption: ASTM C1104, <2 percent by weight.
 4. Hot shrinkage: ASTM C 356, at 250 degrees F (121 degrees C): < 1 percent length, width, or height.
 5. Maximum velocity on coated air side: ASTM C1071; 5,000 fpm (25.4 m/sec).
 6. Connection: Waterproof vapor barrier adhesive.
 7. Minimum sound absorption coefficients, ASTM C423, Type A mounting (sabins/sq. ft):
 - a. At 250 Hz center band frequency: 0.30 for 1 inch (25 mm) thickness.
 - b. At 500 Hz center band frequency: 0.73 for 1 inch (25 mm) thickness.
 - c. At 1000 Hz center band frequency: 1.02 for 1 inch (25 mm) thickness.
 - d. NRC: 0.70 for 1 inch (25 mm) thickness.
- B. Adhesive: Waterproof, ASTM E162 fire-retardant type, duct liner adhesive, air-dried, compatible with insulation. Water-based (ASTM C916) preferable, and required for occupied buildings. Solvent-based contact adhesive may be used in unoccupied buildings, except where prohibited by requirements of LEED certification or other requirements.
- C. Repair Coating: Vac Systems International Tough-Coat acrylic polymer mechanical insulation repair coating.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad with press-on head. Heads must be cupped or beveled; flat washer type not allowed.
- E. Storage and Exposure: Avoid exposure to direct sunlight.

2.5 FIRE RESISTIVE DUCT WRAP (NOT REQUIRED FOR LISTED DOUBLE-WALL GREASE DUCT)

- A. General:
1. Work includes labor, material, and equipment to provide 2 hour fire resistive rated grease or air duct enclosure as a shaft alternative and a method for providing zero-inch clearances around commercial kitchen grease duct exhaust systems to combustible materials.
 2. These Specifications are based on 3M Fire Barrier Duct Wrap 615+ materials. Where installation requirements of substituted products differ from these Specifications, the more stringent requirements shall apply.
- B. Listing Agency: Provide products that are listed by at least one the following:
1. Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory" category XHEZ or XHBN as appropriate.
 2. Omega Point Laboratories (OPL), in "Directory of Listed Products, Through Penetration Fire Resistance Directory."
 3. Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.

- C. Furnish products identical to those tested for classification by listing agency.
- D. Mark product packing with classification marking of listing agency.
- E. Duct Wrap Exposed to View: Provide products with flame spread index of less than 25 and smoke developed index of less than 450, when tested in accordance with ASTM E84.
- F. Duct Wrap Exposed to View, Traffic, Moisture, or Physical Damage: Provide products that after curing do not deteriorate when exposed to those conditions during and after construction.
- G. Materials: Use only products specifically listed for use in Listed systems.
- H. Submittals: Submit test reports substantiating performance requirements and Code compliance along with manufacturer's installation instructions.
- I. Duct Wrap: 3M Fire Barrier Duct Wrap 615+: Lightweight, non-asbestos, high temperature, bio-soluble, calcium-magnesium-silicate (CMS) non-woven blanket, encapsulated in a scrim-reinforced foil, blanket thickness of 1.5 inches (38 mm) for ventilation and grease duct applications.
 - 1. Color: White blanket, aluminum foil encapsulated.
 - 2. Weight: 0.9 psf (4.38 kg/m²).
 - 3. Density: 6 pcf (96.1 kg/m³) nominal.
 - 4. Thermal Conductivity (k-value) at 500 degrees F (260 degrees C) (ASTM C411, ASTM C518): 0.48 Btu/(ft² x h x F) (0.07 W/(m x K)).
 - 5. R-Value per ASTM C518 at ambient 77 degrees F (25 degrees C): At least 6.3 F-ft²-hr/Btu (1.1 K-m²/W)..
 - 6. Service range up to 2000 degrees F (1093 degrees C)
 - 7. Fire Resistance: For use in 1 hour and 2 hour fire resistant systems.
 - 8. Product complies with ASTM E2336 test standard.
 - 9. Product complies with ISO 6944 test standard.
 - 10. Through-penetration per ASTM E814 (UL 1479).
 - 11. Non-combustible per ASTM E136.
- J. Accessory Materials:
 - 1. Tapes:
 - a. High Performance Filament Tape: 3M tape No. 898, 1 inch (25 mm) wide.
 - b. FSK Facing Tape: 3M tape No. 3320, with aluminum foil, fiberglass scrim, and kraft paper backing. Nominal 3 inches (76 mm) wide or 4 inches (102 mm) wide. For sealing cut blanket edges and seams.
 - 2. Banding Material: Stainless or carbon steel banding, 1/2 inch (13 mm) wide x 0.015 inch (0.4 mm) thick, as stated in duct wrap Design Listing.
 - 3. Insulation Pins and Clips:
 - a. Copper-coated steel pins, 12 gauge with a minimum length of 4 inches (102 mm), with 2.5 inch (64 mm) square galvanized steel speed clips.
 - b. 12 ga insulated cup head steel pins.
 - 4. Through-Penetration Fire Stop Materials:
 - a. Packing Material: Scrap pieces of fire resistive duct wrap, 1.5 inches (13 mm) thick, or 4 pcf (56 kg/m³) mineral wool.
 - b. Sealant: 3M 2000+ premium non-slump silicone sealant, or other sealant as stated in the duct wrap's Design Listing.

5. Access Doors: 3M Fire Barrier Grease Duct Access Doors.
 - a. Steel angle opening frame, with threaded holes for fasteners.
 - b. Access cover, minimum 16 ga, with loop handle, labeling, and fastener holes.
 - c. Thumb screws for initial fastening of access cover to frame.
 - d. 3M Fire Barrier Grease Duct Access Door Hardware Extension Kit, including threaded rods, wing nuts, nuts, and washers.
 - e. Outer plate, minimum 16 ga steel, field furnished.
 - f. Layers of fire-resistant duct wrap, sized per manufacturer's instructions, with edges sealed with aluminum foil tape.
 - g. Insulation pins and speed clips to fasten the layers of duct wrap to the inside face of outer steel plate.
 - h. Label for outer plate.

K. Execution: See Part 3 of this Section.

2.6 GLASS FIBER INSULATION SEALING TAPE

- A. Self-adhesive tape with integral vapor barrier, pressure sensitive acrylic-based or rubber-based adhesive, and release liner strip. Width 3 in. nominal.
- B. Manufactured by VentureTape, by the insulation manufacturer, or by one of the other tape manufacturers listed in the article "Manufacturers" in this Section.
- C. Types:
 1. For rigid and semi-rigid insulations, tape shall be reinforced type. For flexible "duct wrap" insulation, tape shall be either reinforced or non-reinforced.
 2. White or aluminum outer surface to match the insulation.
 3. Reinforced: Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier layer.
 - a. Aluminum Finish with FSK: VentureTape 1525CW.
 - b. White Finish with ASJ: VentureTape 1540CW
 - c. White Finish with PSK: VentureTape 1531CW.
 4. Non-Reinforced: Foil insulation tape. Dead-soft temper 2 mil thick aluminum foil, without reinforcement. Hand-tearable.
 - a. Venture Tape 3520CW.
 5. Performance:
 - a. Peel Adhesion: PSTC-101 with 20 minute dwell, 45 oz/in..
 - b. Shear Adhesion: PSTC-107, 2.2 psi after 24 hours.
 - c. Tensile Strength: PSTC-131:
 - 1) Reinforced Types: 40 lb/in.
 - 2) Non-reinforced Types: 21 lb/in.
 - d. Elongation: PSTC 131, 6 percent maximum.
 - e. Service Temperature: -40 to 240°F.
 - f. UL 723 listed or classified (flame/smoke rating).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 01 Section “Project Management and Coordination”: Verification of existing conditions before starting work.
- B. Verify that ductwork has been tested before applying insulation materials.
- C. Verify that surfaces are clean, foreign material removed, and dry.
- D. Verify that insulation materials are clean and dry. Discard any materials that exhibit signs of moisture damage, contamination, mold, mildew, or other biological growth. Discard any materials used in the air handling airstream if they have been exposed to water.

3.2 INSTALLATION

- A. Division 01 Section “Quality Requirements”: Manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. In addition to new ductwork, provide insulation for surfaces of existing ductwork that is not insulated. Field-verify scope of existing ductwork.
- D. Provide insulation for surfaces of ductwork, as indicated and specified. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
- E. Insulated Ductwork Conveying Air below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- F. Insulated Ductwork Conveying Air above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- G. Ductwork Exposed below 10 feet above finished floor in Mechanical Equipment Rooms or below 8 feet above finished floor in Finished Spaces: Provide glass fiber rigid insulation with vapor barrier jacket.
- H. Where rigid glass fiber insulation is scheduled, semi-rigid glass fiber insulation may be used on round and flat oval ducts and irregular shapes, and preformed pipe insulation may be used on small diameter round ducts.

- I. Inspection Plates and Test Holes: Provide, where required, in ductwork or casings for balance measurements. Test holes shall be factory fabricated, airtight, and noncorrosive with screw cap and gasket. Extend cap through insulation.
- J. Install insulation after ductwork and equipment have been tested and approved.
- K. Ensure that surface is clean and dry prior to installation. Ensure that insulation is dry before and during application. Finish with system at operating conditions.
- L. Ensure that insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material, properly sealed.
- M. Finish insulation neatly at hangers, supports and other protrusions.
- N. Locate insulation or cover seams in least visible locations.
- O. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.
- P. Do not insulate exposed ductwork in conditioned spaces or ductwork that is acoustically lined, unless otherwise specified or indicated on the Drawings.
- Q. Wherever exposed ductwork for air conditioned systems passes through non air conditioned spaces, insulate ductwork with glass fiber rigid insulation with vapor barrier, to prevent condensation.
- R. Standing seams, supporting angles and flanges on insulated ductwork shall be insulated with thickness equal to the duct and edges shall be finished and vapor sealed.
- S. Mechanical fasteners shall not be riveted or screwed to the duct and shall not penetrate the metalwork.
- T. For supply or return ductwork which is required to be insulated, insulation shall be continuous and shall include the insulating of register, grille and diffuser connection plenums/boots.
- U. Duct and Plenum Liner Application:
 - 1. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.
 - 2. Provide duct liner where:
 - a. Indicated on the Drawings.
 - b. Specified.
 - 3. Install duct liner in accordance with SMACNA standards.
 - 4. Install elastomeric foam duct liner in accordance with manufacturer's recommendations.
 - 5. Adhesive: Apply to duct sheet metal for 90 percent coverage. Clean the duct before applying adhesive.
 - 6. Mechanical Fastening: In addition to adhesive, provide mechanical fastening devices meeting the following requirements:
 - a. Are spaced in accordance with SMACNA Standards and Manufacturer's recommendations.
 - b. When installed, are as corrosion-resistant as G60 coated galvanized steel.
 - c. Will not adversely affect the fire-resistant classification of liner and adhesives.
 - d. Do not damage the liner when applied as recommended by the manufacturer.
 - e. Do not cause leakage in the duct.

- f. Do not project more than nominally into the airstream.
 - g. Will indefinitely sustain a 50 lb (222 N) tensile dead load test perpendicular to the duct wall.
 - h. Have a permanent, waterproof bond to the duct wall.
 - i. Are the correct length for the specified liner thickness.
7. Self-Adhesive Elastomeric Foam Insulation: If manufacturer's instructions recommend omitting mechanical pin fasteners at all air velocities, they may be omitted. Clean the duct with recommended liquid cleaner before installing insulation.
 8. Seal and smooth liner airstream surface penetrations, cuts, tears, edges, and transverse and longitudinal joints with adhesive or acrylic polymer repair coating, compatible with liner surface coating.
 9. Corners: Cut and fit liner in the corners of rectangular duct sections to assure butted edge overlapping. Longitudinal joints in duct liner shall not occur except at the corners of ducts unless the size of the duct and standard liner product dimensions make joints necessary.
 10. Transverse Joints: Butt liner neatly without gaps.
 11. Provide securely-installed metal nosings that are either channel or zee profile or are integrally-formed from the duct wall over transversely oriented liner edges facing the airstream at fan discharge, at access doors, and at any interval of lined duct preceded by unlined duct. In addition, where velocities exceed 2,000 fpm (10.2 mps), provide metal nosing on upstream edges of liner at every transverse joint.
 12. For edges of lining exposed to the airstream that are not protected by metal nosings, coat with adhesive or acrylic polymer repair coating. Cover raw insulation such that no fibers are released.
 13. Where dampers, turning vane assemblies or other devices are placed inside of lined duct or fittings, install to not damage the liner or cause erosion of the liner. The use of metal hat sections or other buildout means is optional; when used, secure buildouts to the duct wall with bolts, screws, rivets or welds.
 14. Do not install duct liner in fresh air intake ductwork between the outside intake opening and the fan or other air moving device, or within 10 feet (3 m) downstream of a cooling coil or humidifier.

3.3 FIRE RESISTIVE DUCT WRAP FOR KITCHEN GREASE EXHAUST

- A. Install duct wrap system in accordance with manufacturer's instructions and referenced standards.
- B. Install duct wrap in direct contact with the duct it encloses. Install in accordance with details of the product's listing. Protect every portion of duct with no less than 2 layers. Overlap both perimeter and longitudinal joints minimum of 3 in. (76 mm) per layer of material. If required, tape seams using minimum 3 in. (76 mm) wide aluminum foil self-adhesive tape.
- C. Air Duct Enclosure Wrap: Follow same traditional wrap method with exception of utilizing a 3 in. (76 mm) perimeter overlap in conjunction with longitudinal butt joint wrap plus duct wrap collar over exterior layer joints.
- D. Filament tape may be used as a temporary securing measure on both layers until banding hardware is in place. Band exterior layer spaced no more than 10.5 in. (267 mm) on center, and within 1.5 in. (39 mm) of overlapped seams.

- E. For duct widths greater than 24 inches (610 mm), weld insulation pins to bottom of horizontal and outer vertical duct runs. Space on a grid in accordance with duct wrap manufacturer's instructions. Impale duct wrap over pins and secure with galvanized steel speed clips before banding is applied.
- F. Locate grease duct access doors at horizontal cleanouts as required by local Codes. Protect with 3 layers of duct wrap, each layer overlapping previous by 1inch (25 mm) on all sides and in accordance with manufacturer's instructions.
- G. Install duct access doors and their insulation in accordance with manufacturer's instructions. Provide labeling in accordance with NFPA 96 and Code requirements.
- H. Where fire rated duct wrap is used as a shaft enclosure, firestop at fire separations in accordance with the duct wrap manufacturer's recommendations.
- I. Protect fire wrap from damage when installed in locations accessible to building occupants.
- J. Repair Procedure:
 - 1. Repair damaged duct wrap in accordance with manufacturer's instructions.
 - 2. Remove damaged section. Apply a new section of same dimension. Place and fit ensuring same overlap that existed previously. Place banding around new duct wrap material and tension to sufficiently hold in place.
 - 3. If damage has penetrated to interior layer, remove affected sections and reinstall as specified in Installation.

3.4 FIELD INSPECTION

- A. Visually inspect to ensure that materials used conform to Specifications. Inspect installations progressively for compliance with requirements.

TABLE I
DUCTWORK INSULATION MATERIAL AND WALL THICKNESS

DUCTWORK TYPE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS
Supply ductwork for cooling systems concealed above ceilings	Glass Fiber, Flexible	Yes	1 1/2"
Exhaust ductwork from exterior building openings (such as louvers and roof hoods) to 4 feet interior of motorized damper or backdraft damper	Glass Fiber, Flexible (only if ductwork is concealed)	Yes	1 1/2"
	Glass Fiber, Rigid	Yes	1"
Outside air intake ductwork	Glass Fiber, Flexible (only if ductwork is concealed)	Yes	2 layers of 1 1/2" with staggered joints
	Glass Fiber, Rigid	Yes	2 layers of 1" with staggered joints
Exposed supply ductwork in mechanical or equipment rooms	Glass Fiber, Rigid	No for heating only systems, Yes for cooling systems	1"

END OF SECTION 230713

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SECTION 230719 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.
- C. Shields, Inserts, and Saddles.

1.2 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures”.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.
- B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.4 REGULATORY REQUIREMENTS

- A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches.
- B. Insulation materials and accessories shall be asbestos-free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01 Section “Product Requirements”: Transport, handle, store, and protect products.
- B. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 Section “Product Requirements”: Environmental conditions affecting products on site.

- B. Maintain ambient conditions required by manufacturers of each product.
- C. Maintain temperature before, during, and after installation for minimum of 24 hours.

1.7 EXISTING PIPING

- A. Insulate existing piping as indicated on the Drawings. Contractor shall be responsible to field-verify quantities and sizes. Provide access to existing piping as required for complete insulation. Remove existing finishes and existing insulation as required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Elastomeric Foam Products:
 - 1. Armacell LLC.
 - 2. K-Flex USA.
 - 3. No substitutions.
- B. Glass and Mineral Fiber Products:
 - 1. Knauf Insulation.
 - 2. Certainteed Corporation.
 - 3. Johns Manville.
 - 4. Owens Corning.
 - 5. No substitutions.
- C. Accessories:
 - 1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
 - 2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
 - 3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket systems).
 - 4. Pabco/Childers Metals, division of ITW Insulation Systems (products: metal jacket systems, and accessories).
 - 5. Pittsburgh Corning (product: cellular glass insulation for high-density inserts).
 - 6. Proto Corporation (product: plastic jacket systems).
 - 7. Vac Systems International (product: Tough Coat acrylic polymer mechanical insulation repair coating).

2.2 ELASTOMERIC FOAM

- A. Products:
 - 1. Armacell: AP Armaflex and AP Armaflex FS pipe and sheet insulation.
 - 2. K-Flex USA: Insul-Tube and K-Flex LS pipe insulation, and Insul-Sheet S2S and K-Flex LS sheet insulation.
 - 3. No substitutions.

- B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 1. 'K' ('Ksi') value: ASTM C177; 0.277 Btu-in/(hr-sq.ft-°F) at 75°F.
 2. Minimum service temperature: -70°F (-57°C) (flexible to -20°F).
 3. Maximum service temperature: 220°F.
 4. Maximum moisture absorption: ASTM C209, 0.2% by volume; or ASTM D1056, 5% by weight.
 5. Moisture vapor transmission: ASTM E96; 0.08 perm-inches.
 6. Connection: Waterproof vapor barrier adhesive.
- C. White Insulation for Exposed Locations: Where exposed to the occupants' view, provide insulation in white or off-white color, Armacell's AP/Armaflex W or K-Flex USA's Insul-Tube White and Insul-Sheet White.
- D. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- E. Insulated Hanger Inserts: At Contractor's option, Armacell Armafix IPH insulated pipe hanger inserts may be used at hanger locations.
 1. Engineered from Armaflex insulation, with inserts of CFC-free PPUR/PIR polyurethane foam insulation bearing segments.
 2. Outer shell of 30 mils-thick painted aluminum.
 3. Self-adhesive closure strip.
 4. Provide Armaflex insulation tape, wrapped around the IPH prior to placing in the hanger.

2.3 GLASS FIBER

- A. Insulation: ASTM C547; rigid molded, noncombustible.
 1. 'K' ('Ksi') value: ASTM C177, 0.24 Btu-in/(hr-sq.ft-°F) at 75°F.
 2. Maximum service temperature: 850°F.
 3. Maximum moisture absorption: 0.2 percent by volume.
- B. Vapor Barrier Jacket:
 1. ASTM C1136, White kraft paper with glass fiber yarn, bonded to aluminized film.
 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- F. Indoor Vapor Barrier Finish:
 1. Cloth: Untreated; 9 oz/sq yd weight.
 2. Vinyl emulsion type acrylic, compatible with insulation, white color.
- G. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- H. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

- I. Insulating Cement: ASTM C449/C449M.

2.4 JACKETS

A. PVC Plastic.

1. Jacket: ASTM D1784, One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum service temperature: 0°F.
 - b. Maximum service temperature: 150°F.
 - c. Moisture vapor transmission: ASTM E96; 0.002 perm-inches.
 - d. Thickness: 15 mil for indoor use, 30 mil for outdoor use and in high-abuse areas such as corridors and locker rooms.
 - e. Connections: Brush on welding adhesive, tacks (for heating systems only) or pressure sensitive color matching vinyl tape.
2. Covering Adhesive Mastic: Compatible with insulation.

B. ABS Plastic:

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum service temperature: -40°F.
 - b. Maximum service temperature of 180°F.
 - c. Moisture vapor transmission: ASTM E96; 0.012 perm-inches.
 - d. Thickness: 30 mil.
 - e. Connections: Brush on welding adhesive.

2.5 SHIELDS, INSERTS, AND SADDLES

A. Shields:

1. Carpenter and Paterson Figure 265GS, or equal.
2. Galvanized or electro-galvanized steel, minimum 12 inch length, minimum 120-degree arc, minimum 18 gauge.
3. Provide contact adhesive to glue shields to the insulation.

B. Snap-On Shields:

1. Cooper B-Line "Snap'N Shield".
2. Snap-N Shield is an acceptable substitute for metal shields when installed with strut trapeze hangers on horizontal piping.
3. Paintable polypropylene plastic 12-inch long preformed shields, snap-on design for attachment to strut.
4. Gluing is not required with Snap-N Shield.
5. Provide black or white color to match the insulation in areas exposed to public view.

C. Inserts:

1. Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
2. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

- D. Saddles:
 - 1. Factory fabricated of curved carbon steel plate, of same overall thickness and contour as adjoining insulation. Sides designed for welding to pipe. Center support plate for pipe sizes 12 inches and larger.

2.6 MANUFACTURER'S STAMP OR LABEL

- A. Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to the project site for use shall have the manufacturer's stamp or label attached giving name of manufacturer, brand, and description of material. Insulation packages and containers shall be asbestos-free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Division 01 Section "Quality Requirements": Manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards where applicable.
- C. Provide insulation for surfaces of new piping and for surfaces of existing piping that is uninsulated, as indicated and specified.
- D. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, applicable State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
 - 1. International Energy Conservation Code (IECC): Chapter 5 of the Code allows the use of ASHRAE 90.1 insulation thicknesses instead of the Minimum Pipe Insulation table which is in Chapter 5 of the IECC. This Specification does not reference the table in IECC.
- E. Piping systems requiring insulation, types of insulation required, and insulation thickness shall be as listed in Table I herein. For piping not listed in Table 1, insulate to meet Code requirements, using suitable specified materials, subject to Architect's approval. Except for flexible unicellular insulation, insulation thicknesses as specified in Table I shall be one inch greater for insulated piping systems located outside the building and in unconditioned spaces. Unless otherwise specified, insulate fittings, flanges, and valves, except valve stems, hand wheels, and operators. Use factory pre-molded, precut, or field-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be factory cleanable, grease resistant, non-flaking, and non-peeling.
- F. Exposed Piping: Locate insulation and cover seams in least visible locations.

- G. Insulated Pipes Conveying Fluids Below Ambient Temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- H. Glass Fiber Insulated Pipes Conveying Fluids below Ambient Temperature:
 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- I. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- J. For hot piping conveying fluids over 140°F, insulate flanges and unions at equipment.
- K. Glass Fiber Insulated Pipes Conveying Fluids above Ambient Temperature:
 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- L. For piping which may operate at a range of temperatures (for example, heat recovery and heat exchange piping), provide insulation and vapor barriers as are suitable for the entire range of operation.
- M. Large Valve Bodies and Other Fittings: Large valves and other fittings requiring service access may be insulated with removable, reusable equipment covers with “Velcro” closures.
- N. Branches to Expansion Tanks: For chilled water systems, insulate completely. For hot water systems, insulate from the connection at the main to at least 10 feet toward the tank.
- O. Branches to Gauges, Sensors, Drains, and Vents: Insulate branches to gauges, sensors, drains, and vents as for active sections of piping. For piping with operating temperatures above ambient, insulate to at least 6 inches from the active main. For temperature devices, insulate to include the sensing bulb or other element. For pressure devices in hot piping with syphon loops, insulate from the active main to the syphon loop, but it is not necessary to insulate the syphon loop or the portion of the branch on the device side of the syphon loop.
- P. Shields, Inserts, and Saddles:
 1. Application: Provide shields at hangers. Provide inserts for piping 2 in. nominal size or larger.
 2. Shield location: Between insulation jacket and hanger.
 3. Insert location: Between support shield and piping and under the finish jacket.
 4. Saddle location: Between support shield and piping.
 5. Glue shields to outside of insulation after system is filled and run at operating temperature.
 6. Align mid-length of shields, inserts, and saddles with the hanger centerline.
- Q. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.

- R. Pipe Exposed in Mechanical Equipment Rooms 10 feet or Less Above Finished Floor:
 - 1. Piping Which Crosses Walking and Service Access Paths 4 feet or Less Above Finished Floor: Finish with PVC or ABS jacket and fitting covers.
 - 2. Piping Exposed within Gymnasium: Finish with PVC or ABS jacket and fitting covers.
- S. Pipe Exposed in Finished Spaces 10 feet or Less Above Finished Floor: Finish with PVC or ABS jacket and fitting covers.

3.3 UNIFORM INSTALLATION

- A. Systems shall use a single insulation type throughout the installation.

3.4 PREPARATION

- A. Insulate piping after system tests have been completed and surfaces to be insulated have been cleaned of dirt, rust, and scale and dried. Ensure full range of motion of equipment actuators. Modify insulation to avoid obstruction of valve handles, safety reliefs, and other components requiring movement. Allow adequate space for pipe expansion. Install insulation with jackets drawn tight and cement down on longitudinal and end laps. Do not use scrap pieces where a full length section will fit. Insulation shall be continuous through sleeves, wall and ceiling openings. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at the manufacturer's recommended coverage per gallon. Individually insulate piping. Provide a moisture and vapor seal where insulation terminates against metal hangers, anchors and other projections through the insulation on surfaces for which a vapor seal is specified. Keep insulation dry during the application of any finish. Bevel and seal the edges of exposed insulation. Unless otherwise indicated, do not insulate the following:
 - 1. Piping in radiation enclosures, or within cabinets of unit heaters.
 - 2. Valve hand wheels.
 - 3. Fire protection pipes. Vibration isolating connections.
 - 4. Adjacent insulation.
 - 5. ASME stamps.

3.5 PIPING INSULATION

- A. Pipe Insulation (Except Elastomeric Insulation): Place sections of insulation around the pipe and joints tightly butted into place. The jacket laps shall be drawn tight and smooth. Secure jacket with fire resistant adhesive, factory applied self-sealing lap. Cover circumferential joints with butt strips, not less than 3-inches wide, of material identical to the jacket material. Overlap longitudinal laps of jacket material not less than 1-1/2 inches. Adhesive used to secure the butt strip shall be the same as used to secure the jacket laps. When a vapor barrier jacket is required, as indicated in Table I, or on the ends of sections of insulation that butt against flanges, unions, valves, fittings, and joints, use a vapor-barrier coating conforming to manufacturer's weatherproof coating for outside service. Apply this vapor barrier coating at longitudinal and circumferential laps. Patch damaged jacket material by wrapping a strip of jacket material around the pipe and cementing, and coating as specified for butt strips. Extend the patch not less than 1-1/2 inches past the break in both directions. At penetrations by pressure gauges and thermometers, fill the voids with the vapor barrier coating for outside service. Seal with a brush coat of the same coating. Where penetrating roofs, insulate piping to a point flush with the top of the flashing and seal with the vapor barrier coating. Butt tightly the exterior insulation to the top of the flashing and interior insulation. Extend the exterior metal jacket

2 inches down beyond the end of the insulation. Seal the flashing and counterflashing underneath with the vapor barrier coating.

- B. **Elastomeric Foam Insulation:** Bond cuts, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. Where pipes penetrate fire walls, provide mineral-fiber insulation inserts and sheetmetal sleeves. Insulate flanges, unions, valves, and fittings in accordance with manufacturer's published instructions. Apply two coats of vinyl lacquer finish to elastomeric foam insulation before applying PVC jacket in outside locations.
- C. **Sleeves and Wall Chases:** Where penetrating interior walls, extend a metal jacket 2 inches out on either side of the wall and secure on each end with a band. Where penetrating floors, extend a metal jacket from a point below the back-up material to a point 10 inches above the floor with one band at the floor and one not more than one inch from end of metal jacket. Where penetrating exterior walls, extend the metal jackets through the sleeve to a point 2 inches beyond the interior surface of the wall.

3.6 FIELD INSPECTION

- A. Visually inspect to ensure that materials used conform to specifications. Inspect installations progressively for compliance with requirements.

TABLE I
PIPING INSULATION MATERIAL AND WALL THICKNESS

SERVICE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS AT THE FOLLOWING PIPE DIAMETERS					
			<1"	1" to <1.5"	1.5" to <4"	4" to <8"	8" or Greater	
Heating Systems (Hot Water Supply and Return)								
140°F to 200°F	Glass Fiber	No	1.5"	1.5"	2"	2"	2"	
Air Conditioning Condensate Drain Located Inside Building	Elastomeric Foam	N/A	0.75"	0.75"	1"	1.5"	1.5"	
	Glass Fiber	Yes	0.75"	0.75"	1"	1.5"	1.5"	
Refrigerant Suction and Liquid Piping								
Operating Temperature								
40°F to 60°F	Elastomeric Foam	N/A	0.75"	1"	1"	1.5"	2"	
Below 40°F	Elastomeric Foam	N/A	1"	1"	1"	1.5"	2"	

END OF SECTION 230719

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SECTION 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Direct Digital Control (DDC) equipment.
- B. Software.
- C. Installation.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Access Doors.
- B. Valves - piping connections.
- C. Pressure taps.
- D. Thermal wells.
- E. Dampers - ductwork connections.

1.3 SYSTEM DESCRIPTION

- A. A fully integrated Automatic Temperature Control (ATC) Building Management and Control System incorporating Direct Digital Control (DDC), energy management, equipment monitoring, and control consisting of the following:
 - 1. Microcomputer-based equipment controllers interfacing directly with sensors, actuators and environmental delivery systems.
 - 2. Electric controls and mechanical devices for items indicated on Drawings and described hereinafter including dampers, valves, and motor drives.
 - 3. Microcomputer-based terminal controllers interfacing with sensors, actuators, and terminal equipment control devices.
- B. Submittals, data entry, electrical installation, programming, start up, test and validation, instruction of Owner's representative on maintenance and operation, as built documentation, and system warranty.
- C. System Summary:
 - 1. The intent of this project is to provide a new ATC system with electronic actuators for the new building.
 - 2. Air handling units, rooftop HVAC units, unit ventilators and terminal heating units which are designated to be controlled by a temperature sensor shall be interfaced with the DDC system, such that monitoring and setpoint adjustment shall be accomplished through the graphical user interface at the operator workstation.
 - 3. ATC Contractor shall coordinate closely with Commissioning Authority for manipulation and functional testing of mechanical systems.

4. The Open Protocol of choice for this project is BACnet. Herein, any Open Protocol Controller referenced in this document shall be a native BACnet controller or device. All controllers for this project will natively utilize the BACnet Protocol without the use of a Gateway. Gateways that may be necessary to interface with specific equipment manufacturers equipment or systems must be submitted for approval.
5. The intent of this specification is to provide and install an Open Source Non-Proprietary Building Automation Control System (BACS) based on the Tridium Niagara AX/N4 Platform and a network of freely programmable interoperable open protocol digital controllers. The Interoperable controllers must be fully programmable via any vendors version of the Niagara WorkBench tool. Controllers that are not programmable or configurable directly within any vendors version of the Niagara AX/N4 Workbench are not acceptable and will be rejected.
6. Products requiring a licensed, non-embedded, off site programming tool are not acceptable. Open source as referred to herein must mean that the Tridium Niagara Network Area Controller and the Interoperable Digital Controllers (IDC) products are available from multiple contractor and vendor sources, affording the Owner freedom of choice and competitive bidding for the initial installation of the (BACS) and future system expansions and modifications not limited by contractor, vendor or networking protocol. No territorially restricted OEM brands, single vendor or “branch only” products are acceptable. All products must be available for purchase by any qualified contractor that the Owner chooses to do the initial installation and any future expansion or modifications.
7. All JACE’s and Controllers must be fully programmable or configurable from within any vendor’s version of the Niagara AX/N4 Platform. Controllers that require a separate or 3rd party programming tool are not acceptable and will be rejected.
8. Contractor must be an authorized and approved representative of the product which they propose to install.
9. Furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation Control System (BACS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.
10. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, must be provided without additional cost to the Owner.
11. The Owner must be the named license holder of all software associated with any and all incremental work on the project(s).
12. The entire Building Automation Control System must be comprised of a network of interoperable, stand-alone digital controllers communicating via Open communication protocols to a Network Area Controller (JACE). Temperature Control System products must be by approved manufacturers.
13. The Building Automation Control System must be comprised of Network Area Controller or Controllers (JACE) within each facility. From herein, NAC must refer to a JACE. The NAC must connect to the Owner’s local or wide area network, depending on configuration. The controllers must be located adjacent to the equipment they monitor or control and must be sized for the task assigned to them. The system must utilize distributed processing architecture and one controller must be provided for each major piece of equipment or system controlled or monitored. Access to the system, either locally in each building, or remotely from a central site or sites, must be accomplished through standard Web browsers, via the local area network. Each NAC must communicate to Open Protocol controllers and other open protocol systems/devices provided under “Related Divisions”.
14. The BACS as provided in this Division must be based on a hierarchical architecture incorporating the Niagara AX/N4 Framework™. Systems not developed on the Niagara AX/N4 Framework™ platform are unacceptable.

15. The BACS must monitor and control equipment as called for by the "Sequence of Operation" and points list.
16. The BACS must provide full graphic software capable of complete system operation for up to 34 simultaneous Thin-Client workstations.
17. Contractor to provide conduit and boxes for wall sensors. Contractor shall coordinate as necessary to install conduit and wall boxes prior to installation of drywall.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Submittal Shall Consist of:
 1. Qualifications of Supplier/Manufacturer/Installer.
 2. System architecture indicating digital devices.
 3. Data sheets of products.
 4. Valve, damper, and well and tap schedules indicating size, configuration, capacity, and location of equipment.
 5. Wiring and piping interconnection diagrams including panel and device power and sources.
 6. Equipment lists of proposed devices and equipment.
 7. Software design data including flowchart of each direct digital control program showing interrelationship between inputs, outputs, PID functions, and other functions.
- C. Codes and Approvals:
 1. The complete temperature control installation shall be in strict accordance to the national and local electrical codes and the electrical Division of these Specifications. Devices designed for or used in line voltage applications shall be UL listed. Microprocessor based remote and central devices shall be UL916 Listed.
 2. Electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- C. Manuals: Provide the following:
 1. An Operator's Manual with graphic explanations of keyboard use for operator functions specified under Operator Training.
 2. Computerized printouts of equipment controller's data file construction including point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, and others as applicable.
 3. A manual including revised as-built documents of materials required under the paragraph "SUBMITTALS" in this Specification Section.
 4. Two Operators Manuals and two As-Built Manuals shall be provided to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section “Project Requirements.”

1.7 WARRANTY

- A. Components, system software, parts, and assemblies furnished under this Section shall be guaranteed against defects in materials and workmanship for one year from acceptance date.
- B. Labor to troubleshoot, repair, reprogram, or replace system components shall be provided at no charge to the Owner during the warranty period.
- C. Corrective software modifications made during warranty service periods shall be updated on user documentation and on user and manufacturer archived software disks.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SUPPLIERS

- A. Acceptable Manufacturers and Installers:
 - 1. XL Automation, 572 Odlin Road, Bangor, ME 04401
 - 2. Johnson Controls, installed by Trident Controls Inc., 187 Gray Road, Unit A, Cumberland, ME 04021.
 - 3. TAC, I/A Series, installed by Maine Controls, 400 Presumpscot Street, Portland, ME
 - 4. Delta, installed by IB Controls, 3 Pope Road, Windham, ME 04062
 - 5. Siemens, 66 Mussey Road, Scarborough, ME 04074
 - 6. No other substitutions will be permitted.
- B. The Temperature Control Contractor (or Subcontractor) shall hereinafter be referred to as the ATC Contractor.

2.2 SYSTEM REQUIREMENT

- A. Provide complete direct digital and electronic control system consisting of temperature sensors, thermostats, control valves, dampers, operators, indicating devices, interface equipment, and other apparatus required to operate mechanical system and to perform functions specified. Provide controls for the following:
 - 1. Air handling systems.
 - 2. Baseboard Radiation and Radiant Heating Panels.
 - 3. Exhaust fans.
 - 4. Graphical workstation.
 - 5. Provide hardware and software required for remote monitoring of the ATC system through modem interface.

2.3 THERMOSTATS

- A. Freezestats safety low limit shall be duct-mounted, manual reset and automatic reset twenty foot limited fill type responsive to the coolest section of its length.
- B. Electric thermostats shall be line voltage or low voltage type, suitable for the application. They shall have concealed setpoint adjustment and setpoint indicator.
- C. Unit heater aquastats shall be strap-on type.

2.4 TEMPERATURE SENSORS

- A. Temperature sensors shall provide a two-wire connection to the controller that is polarity and wire type insensitive. Sensors shall have communications jacks for connection to the communication trunk to which the controller is connected. The temperature sensor, the connected controller, and other devices on the communications bus shall be accessible by the Graphical Programming tool.
- B. Provide with manual adjustment dials, which shall be programmable through the operator workstation to allow a maximum and minimum range for user adjustment. The max/min range shall initially be set at 68°F min/72°F max.
- C. Provide with override buttons which, when depressed during unoccupied time periods, will override the zone's temperature controls and setpoints to occupied conditions for a user adjustable period of time (initially set for 2 hours).

2.5 AUTOMATIC DAMPERS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Arrow.
 - 3. Greenheck.
 - 4. American Warming & Ventilating.
 - 5. Nailor
- B. Provide automatic control dampers not specified to be integral with other equipment.
- C. Dampers shall be ultra-low leakage type, with blade edges fitted with replaceable inflatable seals to limit damper leakage to 6 CFM per square foot at 1 in. w.g. Side seals shall be stainless steel of the tight-seal spring type.
- D. Dampers in Galvanized Steel Ductwork:
 - 1. For applications not exceeding 36 inches blade length in an individual section, 1,500 fpm face velocity, 2.5 in. w.g. total system static pressure, and 180°F operating temperature, dampers shall be equal to Ruskin model CD-36, low leakage type with roll-formed blades. Blades shall be not less than 16-gauge (1.6 mm) galvanized steel, with PVC-coated polyester fabric edge seals mechanically locked into blade edges.
 - 2. For applications exceeding any of the criteria listed above, dampers shall be equal to Ruskin model CD-60, low leakage type with high-performance airfoil blades. Blades shall be double-skin construction of 14 gauge (2.0 mm) equivalent thickness, with extruded Ruskiprene (TPR) (or equal) blade edge seals locked into blade edges. Dampers shall be suitable for 60

inches maximum single-section width, 6,000 fpm face velocity, up to 11 in. w.g. static pressure (8.5 in. w.g. total system pressure requires maximum section width of 36 inches), and operating temperature range of -72°F to 275°F.

3. Frames shall be not be less than 13-gauge (2.28 mm) galvanized steel, or shall be fabricated of 16-gauge (1.6 mm) galvanized steel hat channel reinforced with corner braces for structural strength equal to 13-gauge channel frames..

E. Dampers in Aluminum Ductwork:

1. Dampers shall be equal to Ruskin CD-50, low leakage type with high-performance airfoil blades. Blades shall be heavy-gauge extruded aluminum, with extruded Ruskiprene (TPR) (or equal) blade edge seals locked into blade edges. Dampers shall be suitable for 60 inches maximum single-section width, 6,000 fpm face velocity, up to 11 in. w.g. static pressure (8.5 in. w.g. total system pressure requires maximum section width of 36 inches), and operating temperature range of -72°F to 275°F.
2. Frames and blades shall be of 6063T5 aluminum alloy. Frames shall have minimum wall thickness of 0.125 inches.

F. Blades shall not be over 8 inches wide. Bearings shall be oilite, stainless steel sleeve, ball-bearing, or nylon. Blade axles shall be 2" plated steel hex rods. Control shafts shall be 2" diameter, 6 inches long, removable. Multiple-section dampers shall have factory-installed jackshafts.

G. Frames channels shall not exceed 1-inch high for damper heights over 12 inches, and shall not exceed 1/2-inch high for damper heights 12 inches and less.

H. Proportional control dampers shall be opposed blade type; two-position dampers shall be parallel blade type.

I. Dampers shall be fabricated of materials that are similar to the ductwork in which they are installed. Provide non-electrically-conductive material between dissimilar metals.

J. Dampers that are located in outside walls or in roof line that are 10 sq ft or larger shall be insulated. Dampers shall be equal to Tamco Series 9000, thermally insulated dampers.

K. Submittals: Submit construction specifications, pressure, velocity, and temperature ratings, and leakage data. Submit a schedule of damper sizes indicating size, location, and face velocity, with required torque for selection of actuators.

2.6 AUTOMATIC CONTROL VALVES

A. Automatic control valves 2-1/2" (64 mm) and smaller shall be screwed type; valves 3" (76 mm) and larger shall be flanged. Valves shall be ANSI-rated to withstand the pressures and temperatures encountered.

B. Unitary valves shall be straight-through type. Stems shall be polished stainless-steel and packing shall be Teflon suitable for chilled water service, hot water service up to 217 psi (1495kPa) at 250°F (121°C), and steam service up to 100 psi (689 kPa) at 337°F (169°C). Seating shall be Teflon or composition disc for water service, and metal-to-metal for steam service. Rubber-paddle-type valves such as Erie valves or Honeywell zone valves are not allowed. Valves with thermal wax motors are not allowed.

- C. Honeywell Asmall linear control valves with Alinear valve actuators (or equal) may be used only for VAV box coils and hot water duct coils; they may not be used for other coil types.
- D. Provide modulating straight-through water valves with equal-percentage contoured throttling plugs. If ball valves are used, they shall be by Belimo, no substitutions, with equal percentage disks.
- E. Modulating valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 3 psi (20.7 kPa). Two-position valves shall be line sized.

2.7 DAMPER AND VALVE ACTUATORS

- A. Damper and valve actuators shall be by BELIMO or approved equal. Actuators shall satisfy the following requirements:
 1. Electronic direct-coupled actuation shall be provided on dampers and valves.
 2. The actuator shall be direct-coupled, enabling it to be mounted directly to the damper or valve without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jack-shaft of up to 1.05 inches (26 mm) when the damper is constructed in this manner. Set-screw type fasteners are not acceptable.
 3. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
 4. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
 5. Proportional actuators shall provide a standard built-in 2 to 10 VDC position feedback signal, and other types of actuators shall be capable of providing an optional position feedback signal.
 6. 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.
 7. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
 8. Actuators used near outdoor air streams shall have a NEMA 2 rated housings for water and moisture resistance. Other actuators shall have NEMA 1 rated housings.
 9. Actuators shall produce no more than a 45 dB(A) noise level when powered and operating, and no more than a 62 dB(A) noise level when in the spring return mode.
 10. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
 11. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be IS09001 certified.
 12. Manual Override:
 - a. Non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered.

- b. Spring return actuators shall have a manual crank at each actuator. If a loose-fit manual lever such as an Allen wrench serves as the manual crank, attach it to the actuator so it is in place for Testing and Balancing, for Commissioning, and when the system is turned over to the Owner.
- B. Automatically controlled devices, unless specified otherwise elsewhere, shall be provided with electric actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off.
- C. Where two or more actuators are to be operated in sequence with each other, sequencing shall be by digital sequencing with separate analog outputs, as specified in the sequence of operation.
- D. Unless otherwise indicated, actuators shall be spring loaded and shall, upon a loss of power, actuate their device to an appropriate fail safe position.
 - 1. Hot water valves - fail safe to fully open
 - 2. Outside and exhaust air dampers - fail safe to fully closed
 - 3. Exhaust fan motorized dampers - fail safe to fully closed
 - 4. Return air dampers - fail safe to fully open
- E. For actuators that are required to “fail safe”, provide spring return actuators. A floating point@ actuators shall not be allowed for these applications. “Floating point” actuators shall be allowed for actuators that are not required to “fail safe”.

2.8 CURRENT TRANSFORMERS

- A. Current transformers (CTs) are not an acceptable substitute for pump or fan monitoring where flow switches or pressure switches are specified.

2.9 DATA INPUTS AND OUTPUTS

- A. Input/output sensors and devices shall be closely matched to the requirements of the remote panel for accurate, responsive, noise-free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.
- B. Duct temperature sensors shall be rigid stem or averaging type as required. Provide water sensors with a separable copper, monel or stainless-steel well.
- C. Differential and Static Pressure Sensors and Switches:
 - 1. Fan proof-of-flow switches shall be adjustable set point and differential pressure type. Current sensors shall be allowed, provided that they are capable of detecting a belt break.
 - 2. Pump proof-of-flow switches shall be adjustable differential pressure type.
- D. Control relays and analog output transducers shall be compatible with equipment controllers output signals. Relays shall be suitable for the loads encountered. Analog output transducers shall be designed for precision closed loop control with pneumatic repeatability error no greater than 12%.
- E. Data inputs and outputs shall be compatible with variable frequency drives; see Division 23 Section “Motors, Drives, and Accessories”.

2.10 TEMPERATURE CONTROL CENTRAL HARDWARE

- A. Operator Workstations: The central operator workstation shall be included in this project. Coordinate with Owner for exact location. Operator workstation shall meet the following minimum criteria:
1. Operator workstation shall be Compaq, Dell, Gateway, Hewlett Packard, or IBM. No substitutions.
 2. Operating System: MS Windows 7 Professional operating system. Windows Vista may be provided, but only if required by the control system. Windows XP and older versions are not allowed. (Operating systems that provide only foreground/background operation, or are based on concurrent DOS, are unacceptable and will be rejected.)
 3. Processor: Intel Pentium dual-core.
 4. RAM: The system shall come standard with at least 256K RAM disk cache and 1 gigabytes of system RAM. Provide 4 DIMM slots with capacity for up to 2 GB.
 5. High Resolution Color Monitor: Provide with a 19" LCD flat panel 0.29 dot pitch Super VGA (1280 X 1024 resolution @60, 75 Hz) color monitor and driver.
 6. Video Card: 256 megabyte of video RAM, dual-monitor capability, Blu-ray disc compatibility.
 7. Hard Drive: 160 GB capacity. 7,200 RPM, 10 millisecond average access time.
 8. DVD +/- RW Drive: Read/write 48xCD/16xDVD drive, with CD creator software.
 9. CD-RW/DVD-ROM Drive: Combination 48xCD-RW/16xDVD-ROM drive.
 10. Optional Zip Drive: An internal 250 MB zip drive or equivalent, for the purpose of manually and automatically backing up fixed system data, may be provided at Contractor's option.
 11. Floppy Disk Drive: 1.44 megabyte storage, 3.5" disk size. At the Control Contractor's option, an integral multi-card reader may be substituted.
 12. Mouse and Keyboard: High quality bus or serial mouse with at least 3 buttons and scroll wheel. 104-key keyboard. Either mouse or keyboard shall be able to be utilized interchangeably for operator interface.
 13. Modem: 56K baud phone/fax modem. At the Control Contractor's option, the phone/fax modem may be provided in the master control panel in lieu of in the operator workstation. If the phone/fax modem is located in the master control panel, the control Contractor shall be responsible for costs associated with locating a dedicated telephone line to the appropriate location to allow for remote access to the ATC system.
 14. Ethernet Interface: 10/100 speed.
 15. USB Ports: 8 total, 2 front, 6 back.
 16. Printer: Epson LX-300, 9-pin parallel dot-matrix type printer; tractor feed; 80 column; 337 cps in draft mode; 10-inch maximum paper width; 49 dB sound level; 6,000-hour MTBF (mean-time-between-failure) rating; up to 4 million strokes per wire; with serial, parallel, and USB ports. For reports, alarms and exception messages. Provide one box of tractor-feed paper, and one spare black ribbon cartridge.
 17. Accessories: Provide interconnecting cables and other accessories as required.
 18. Where applicable, provide standard RS232 serial communications port for use with lighting control software (lighting control software by Division 26).
 19. Security Software: Install anti-virus, anti-spyware, and firewall software provided by the Owner. Contact the Owner for requirements.
- B. Equipment controllers shall be 16 bit microprocessor based with EPROM operating system (O.S.). ATC programs and data files shall be non-volatile EEPROM or flash memory to allow simple additions and changes. Each equipment controller shall have an on-board real-time clock with battery backup of a minimum of 30 days.

1. Equipment controllers shall be provided where indicated or specified with capacity to accommodate input/output (I/O) points required for the application plus spare points specified. These panels shall be configured with analog and digital inputs and outputs, and pulse counting totalizers and such that the primary input, the output and control logic shall be resident in a single microprocessor to provide network independent stand-alone closed loop ATC.
 2. Panel electronics shall be installed in suitable enclosures. Equipment room panels shall have hinged doors and shall also contain the load relays, transducers, and associated equipment.
- C. Terminal Equipment Controllers shall be EEPROM based and modularity expandable to accommodate additional points if required for future functional changes or enhancements, and with I/O selected for the application plus specified spares. Terminal controllers shall be capable of processing sensor signals of the applications specified, and shall have capability to drive digital (on-off), pulse width modulation, and true analog (0-10V) outputs. Terminal Controller enclosures shall be compact, finished steel to fit within or on terminal equipment. Each terminal controller shall have complete standalone capability.

2.11 OPERATOR STATION SOFTWARE

- A. Operator Station (OS) software shall include as a minimum the Operating System, Data Base Manager, Communications Control, Operator Interface, Trend and History Files, Report Generator, and Support Utilities.
1. Real time operating system shall be true multi-tasking providing concurrent execution of multiple real time programs and custom program development.
 2. Data Base manager is to manage data on an integrated and non-redundant basis. It shall allow additions and deletions to the data base without any detriment to the existing data.
- B. Operator Interface Software:
1. Operator access to the system is to be under personal ID and password control for up to 100 unique operators.
 2. Up to 100 frequently addressed system points shall be definable as "quick access" points. Each points user address, descriptor, and value/status shall be displayed.
 3. Points (physical and pseudo) shall be displayed with dynamic data provided by the system with appropriate text descriptors, status or value, and engineering unit. Points shall be dynamic and shall continuously update anytime their field status/value changes.
 4. An on-line context-sensitive help utility shall be provided to facilitate operator training and understanding.
 5. Electronic messaging facility shall be provided on the operator station for any operator to enter a message to another operator.
- C. Site Specific Customizing Software:
1. Provide software which will allow the user to modify and tailor the temperature control to the specific and unique requirements of the equipment installed, the programs implemented, and to staffing and operational practices.
 2. Point alarms shall be user-classifiable as critical or non-critical. Critical alarms shall be displayed in a dialog box of the color monitor. Display shall include time and date of occurrence, indication of alarm condition, analog value or status, user address, and alarm message.
 3. A discrete per point detailed alarm-action taking message of up to 480 characters shall be available for each point.

4. Alarms shall be directed to the user selected alarm printer.
 5. Non-critical alarms shall only output to the printer and OS disk in order of occurrence.
 6. Run time limit messages shall be presented and processed as alarm messages except the action message shall be of a maintenance directive nature.
- D. Dynamic trends shall provide for each OS of up to eight user selected points to show real time activity of the associated points. This information shall be printed and/or displayed in numeric, bar chart, curve plot, pie chart, etc., as selected by the operator.
- E. Standard Reports Shall Be Provided Which Shall Be Output onto the Selected Report Printer. The Following Standard Pre-formatted Reports Shall Be Provided:
1. The user shall be provided with a command trace feature selectable on a per point basis allowing the archiving of commands issued to each point.
 2. A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only.
 3. Alarm history. The last 4000 alarm events shall be disk archived. Viewing or printing shall be by entering a date range (from-to).
 4. Operator activity. Operator activity shall be archived. Viewing or printing shall be by entering a desired date range.
 5. Trend reports shall allow the operator to randomly select point archival. Equipment controllers trend points (hardware and software) shall be assignable to PC archive files for display at user selectable intervals of 10 seconds to 24 hours.
- F. Equipment controllers shall be up-line or down-line loadable to or from the OS disk for backup archival.
- G. Provide software to execute and observe diagnostics of any remote device connected to the peer bus and the ability to deactivate and restart the device.
- H. In addition, a word processing utility, graphics package, and spreadsheet shall be available for generic use. The base system software shall include a CRT "windowing" feature to allow the operator to monitor the real time system and use third party software simultaneously.

2.12 GRAPHIC PROGRAMMING

- A. Graphic Programming. Provide hardware and software required for complete equipment controllers ATC programming of plant programs including plant system schematic development, I/O hardware point definition, hardware and software text point descriptors, ATC algorithmic development, a controller software loading utility, and a live programming test facility. At a minimum, the following shall be provided in the graphics package:
1. Exhaust fans- control and status
 2. Floor plans showing temperature sensors - control and status.
 3. Air handling units, rooftop HVAC units and associated pumps, fans, dampers - control and status.
- B. Provide a Boolean logic switching table matrix module for building ON-OFF commands from combinations of and or functions.
- C. Provide a program testing utility which allows live and dynamic monitoring of the graphically displayed control programs provided.

- D. In addition to training specified elsewhere in this Specification, provide 4 days of additional programming training, at a minimum of 4 hours training per day. These 4 days of additional training shall be provided during the 1 year warranty period. They are intended for use by the Owner as questions regarding system operation arise. Coordinate with the Owner.
- E. Provide two sets of programmer's manuals.

2.13 CONTROLLER SOFTWARE

- A. Energy Management application programs and associated data files shall be in non-volatile memory.
 - 1. Optimum Start shall delay equipment start-up based on global outdoor temperature, space temperature, and system response to assure that comfort conditions are reached at scheduled occupancy. The optimum start program shall operate fully stand-alone in the local equipment controllers.
 - 2. A load reset program shall be provided to assure that only the minimum amount of heating, cooling, and electrical energy is supplied to satisfy zone temperature requirements.
- B. Control Software:
 - 1. Each equipment controllers shall contain up to 20 unique user modifiable time programs.
 - 2. Control Application Software shall be customized strictly to meet the detailed requirements of the "Sequence of Operation" specified hereinafter. Equipment controllers and terminal controllers shall be fully programmable. Initial software shall be fully modifiable, and not restricted by vendor's specific configuration guidelines. Equipment controllers control software shall be designed via a graphic programming facility, the detailed graphic design of which shall be provided as system documentation. Control strategies shall be advanced as noted with stabilizing setpoint ramps and procedures to assure slow loading of variable load equipment and economizer modes to prevent unsafe overshoot of controlled pressure and unsafe undershoot of mixed air temperatures during start-up and transition periods.
- C. Management Software:
 - 1. Each equipment controllers shall be provided with a trend archive of at least the last 200 events (digital transitions or analog value changes) of any user selected group of up to 20 points. A stored event shall include date and time, and value or status. Point events shall be displayable at local panels as trend logs for evaluation of control system performance.
 - 2. Each equipment controllers shall monitor analog input points and specified digital points for off-normal conditions. Each alarm shall have an "alarm delay" attribute which shall determine how long (in seconds) a point must be in an off-normal state prior to being considered in an alarm state.
- D. Communications Software: Each equipment controllers shall have a full master peer-to-peer communications module to support global data sharing, hierarchical control, and global control strategies specified.

2.14 DATA COMMUNICATIONS

- A. Equipment controllers shall be interconnected via a primary communications network. Terminal controllers shall also be connected together via secondary networks to provide data concentration and parallel processing. Networks shall support sensor sharing, global application programs, and bus-to-bus communications without the presence of a host PC.

- B. The equipment controller's communications network shall support true peer protocol such that loss of any single device will not cause total bus failure.

PART 3 - EXECUTION

3.1 GENERAL

- A. ATC setpoints, reset schedules, time programs, historical trends shall be displayable at local ATC panels and on the system's operator workstations.

3.2 SPARE POINTS

- A. Provide a minimum of 10% spare points or 16 spare points, whichever is greater, in each ATC control panel for future use. Spare points shall be equally distributed among analog input, analog output, digital input and digital output. It is not intended that spare points be provided in unitary control panels which serve VAV boxes, unit ventilators, fan coil units and heat pumps. It is intended that spare points be provided in master control panels and in panels which serve boiler/mechanical rooms and major equipment such as air handling units.

3.3 INSTALLATION

- A. Wiring and conduits shall be properly supported and run in a neat and workmanlike manner. Wiring and conduits exposed and in equipment rooms shall run parallel to or at right angles to the building structure. Wiring and conduits within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.
- B. The ATC Contractor shall be responsible for electrical installation, including low voltage and line voltage wiring, required for a fully functional control system and not indicated on the Electrical Drawings or required by the Electrical Specifications. Wiring shall be in accordance with local and national codes. Control wiring in boiler room, mechanical room and equipment rooms shall be installed in conduit which shall comply with the requirements of the Electrical Specifications. Electronic wiring shall be #18 AWG minimum THHN and shielded if required.
- C. Provide power for normally-open hot water valves from a central source(s). Interlock with hot water pump(s) to deenergize valves when pump is deenergized.
- D. The ATC Contractor shall enter computer programs and data files into the related computers including control programs, initial approved parameters and settings, and English descriptors.
- E. The ATC Contractor shall maintain CD copies of data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the Owner during training session, and one copy shall be archived in the ATC Contractor's local software vault.
- F. Adjustment/relocation of freezestats shall be performed by the ATC Contractor as required to eliminate nuisance freezestat alarms.

- G. Wall mounted temperature sensors shall be attached either to a wall stud or to blocking, or to an electrical wall box attached to such wall framing. Attaching to gypsum wallboard only shall not be allowed.
- H. Aquastats installed on unit heaters and at any location above 5'-0" (1525 mm) above finished floor shall be installed with adjustment knobs facing downward to facilitate adjustment.
- I. Outdoor air temperature sensor(s) shall be installed on the North side of the building.
- J. Thermostats and temperature sensors are indicated on the Drawings for general location. Terminal heat transfer units and fans which control space temperature shall be provided with thermostatic control, whether or not a thermostat or temperature sensor has been indicated on the Drawings.

3.4 VALIDATION

- A. The ATC Contractor shall completely check out, calibrate, and test connected hardware and software to insure that the system performs in accordance with the approved submittals for specifications and sequences of operations.
- B. Witnessed Validation Demonstration: Shall consist of:
 - 1. Display and demonstrate each type of data entry to show site specific customizing capability.
 - 2. Execute digital and analog commands.
 - 3. Demonstrate ATC loop precision and stability via trend logs of inputs and outputs.
 - 4. Demonstrate energy management performance via trend logs and command trace.

3.5 TRAINING

- A. Training shall be by the ATC Contractor and shall utilize specified manuals and as-built documentation.
- B. Operator training shall include 10 four-hour sessions encompassing:
 - 1. Modifying text.
 - 2. Sequence of Operation review.
 - 3. Selection of displays and reports.
 - 4. Use of specified functions.
 - 5. Setting and adjusting of occupancy schedules.
 - 6. Troubleshooting of sensors.
 - 7. Owner questions/concerns.
- C. Two training sessions shall be conducted at project substantial completion, and the others shall be conducted at the Owner's request and in accordance with the Owner's schedule within a period of 6 months after substantial completion of the project.
- D. At six months after substantial completion, unused training hours shall be, at the Owner's discretion, used for future training of new personnel or reimbursed to the Owner at the Contractor's current hourly service rate.

PART 4 - SEQUENCE OF OPERATION

4.1 GENERAL

- A. Setpoints shall be adjustable by the building operator through the graphic interface on the operator's workstation desktop PC, and through a portable laptop computer plugged into the system at locations throughout the building.
- B. Provide the ability for the Testing and Balancing Agent to connect to the system and change setpoints, to temporarily override setpoints, and to override modes of operation, as may be required for their work.

4.2 ALARMS

- A. Provide the capability to generate alarms, complete with individualized per point alarm message. Disable alarms when their associated system has been disabled as part of a standard control function. For example, when hot water system is inactive during the summer months and hot water temperature drops below the low water temperature alarm set point, do not generate an alarm.
- B. Environmental Alarms: Provide a digital output point to deliver an environmental alarm signal to the building's security system. Provide digital output point and associated wiring to the security panel. Final connection to security panel shall be by Division 26 (coordinate with Division 26). The environmental alarm shall be a single point. The following alarm conditions shall activate the environmental alarm:
 - 1. Low temperature (below 50 deg F) at each room temperature sensor
 - 2. Fan failure on fan coil units or HRU-1

4.3 HEATING MODE

- A. Heating Mode:
 - 1. Heating mode is automatically enabled when outside air temperature drops below setpoint (60°F, adjustable) or when there is a call for heating from the low-temperature alarm in any space. Heating mode is automatically disabled when the outside air temperature rises above setpoint.
 - 2. Heating control valves are powered from dedicated circuits. When the hot water pumps are disabled, control power to the valves is de-energized, allowing the valves to go to failsafe position. This is to prolong actuator life by turning them off in warm weather.
- B. Provide manual override points on the graphics screen to allow the Owner to override the automatic heating and cooling modes.

4.4 FIRE ALARM SYSTEM SHUT-DOWN INTERFACE

- A. For starters that are associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the starter enclosure to interface with the building(s) fire alarm system. Upon receipt of a signal from the building(s) fire alarm system, power to load side of the starter is turned off. Circuitry is provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter

manufacturer, provide a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements of Division 26.

4.5 RE-START PHASING AFTER POWER INTERRUPTION

- A. Upon a power interruption, a loss of power, or at morning start-up, equipment of electrical power greater than or equal to 1.0 HP is started in a staged manner which allows a time delay of 30 seconds between the start of each device.

4.6 HOT WATER PUMPS

- A. Dedicated boiler pumps shall be interlocked to operate anytime that the respective boiler is enabled.
- B. Differential pressure sensor in the distribution piping monitors pump operation and generates an alarm if differential pressure falls below minimum set point, with time delay on start-up.
- C. When the heating system is enabled the pumps are commanded on. Main system loop pumps shall operate and alternate as the lead pump on a schedule acceptable to Owner. If lead main system loop pump fails, lag main system loop pump shall be enabled and an alarm shall be sent to BMS. When the heating system is disabled the heating pumps are commanded off.
- D. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
 - 1. Pump status (all pumps)
 - 2. Pump command (all pumps)
 - 3. Pump run time in hours (all pumps)
 - 4. Differential pressure (main system loop)
 - 5. Differential pressure set point (main system loop)

4.7 HEATING BOILERS (B-1, B-2)

- A. The boilers are enabled by the Building Automation System (BAS). Connect the boiler controllers into the main ATC system for monitoring. Coordinate with Boiler Controller Manufacturer. BAS shall disable boilers during the summer.
- B. The boilers shall maintain a set point temperature of 180 deg F (adj.). If the supply water reset schedule calls for cooler water, the boiler set point temperature decreases to 140 deg F.
- C. The boilers shall sequence on and off as necessary to maintain the main system loop temperature. BMS shall alternate the lead boiler to equalize boiler run times.
- D. Provide the following points under this Section. Coordinate with boiler manufacturer.
 - 1. Boiler set point temperature (all 2 boilers)
 - 2. Hot water supply header temperature
 - 3. Hot water return water temperature
 - 4. Outside air temperature
 - 5. Burner command status (on/off for all 2 boilers)
 - 6. Burner status (on/off /alarm for all 2 boilers)
 - 7. Lead/Lag boiler status

4.8 VRF SYSTEM CONTROL SEQUENCES

- A. Start and Stop Supply Fan(s): AC units with their associated heat pump unit shall run continuously during occupied periods, and cycle on/off during unoccupied period to maintain space temperature setpoint.
- B. Temperature Control: Local wall-mounted space sensors connected to the system control panel will activate the heat pump units and evaporators serving that space.

4.9 HEAT RECOVERY UNIT – HRU-1:

- A. The unit is DDC controlled using electric actuation.
- B. The heat recovery unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied modes.
 - 1. Air Handler Control:
 - a. The supply fan and return fan are constant speed and will be energized together. The energy recovery system will operate when the air handler is in the occupied mode. The hot water coil valve for HRU-1 will modulate to keep the discharge air temperature at 70 degrees F. (adjustable).
 - 2. Safeties:
 - a. High limit static pressure sensor (set at 1 inch wc static pressure higher than scheduled external static pressure) in both supply and return mains shall de-energize the supply and return fans upon activation and shall activate an alarm.
 - b. An automatic reset, capillary tube type freezestat is installed downstream of the heating coil. This freezestat is set to trip at a temperature which is five degrees higher than the manual reset freezestat located downstream of the heating coil.
 - c. Air flow switches are installed in the ductwork for each supply and return fan. The DDC system uses the switches to confirm the fans are in the desired state (i.e. on or off) and generates an environmental alarm if status deviates from DDC start/stop control.
 - d. Duct smoke detectors in the supply and return ducts shall shut down HRU-1 if smoke is detected.

4.10 RADIANT FLOOR HEATING SEQUENCE

- A. Space sensor: Wall-mounted, blank cover, without setpoint dial or thermometer.
- B. Slab sensor: Remote sensing element embedded in the floor slab, ruggedized type, centered between rows of tubing, 6 to 12 feet from outside wall.
- C. When the building is in heating mode and the main hot water pumps are enabled, the radiant floor individual manifold loop 2-position valves shall open to provide heating for their particular manifold. When the spaces served by each individual manifold are satisfied, the individual 2-position valve shall close.

- D. When the slab or room temperature falls below setpoint (slab 80°F, room 70°F, adjustable) the 3-way mixing valve modulates to maintain the supply temperature, according to the following schedule (adjustable):

Outside Air Temp	Supply Temp
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0 degrees F	100 degrees F
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40 degrees F	80 degrees F
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- E. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
1. Manifold valve open/close command (each valve).
 2. Space temperature setpoint.
 3. Slab temperature setpoint.
 4. Space temperature.
 5. Slab temperature.
 6. Outdoor temperature.
- F. Refer to Section 238316 for additional information.

4.11 UNIT HEATERS (UH & CUH)

- A. Space sensor: Wall-mounted, except where sensor is indicated on the Drawings to be mounted on unit at return air inlet. Setpoint dial with limited range, no thermometer.
- B. Setpoint: Provide occupied/unoccupied control. Initial setpoints (adjustable):
1. Unit heaters in mechanical rooms and other unoccupied spaces: 60°F occupied/55°F unoccupied.
 2. Unit heaters in potentially occupied spaces such as vestibules: 68°F occupied/60°F unoccupied.
- C. 2-position 2-way control valve cycles on demand from space sensor.
- D. Fan cycles on demand from space sensor. Provide strap-on aquastat (location: on return piping unless otherwise detailed) set at 100°F (adjustable) to prevent fan operation when hot water is not available.
- E. Mount strap-on aquastat in orientation to be most readily visible from the floor. Insulate over the sensor bulb.
- F. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
1. Space temperature (each space).
 2. Unit on/off command (each unit).

4.12 VENTILATION SEQUENCES

- A. HRU-1 shall be operated on an Occupied-Unoccupied basis.
- B. Exhaust Fan – EF-3 shall operate based upon mechanical room space temperature and shall be enabled if space temperature exceeds 80 deg. (adj.).

4.13 KITCHEN EXHAUST HOOD AND ASSOCIATED FAN

- A. Kitchen hood exhaust fans are enabled through wall switches. See Manufacturer's drawings for additional information.

END OF SECTION 230900

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SECTION 232113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings For:
 - 1. Heating water piping system.
 - 2. Equipment drains and overflows.
- B. Pipe Hangers and Supports
- C. Valves:
 - 1. Ball valves.
 - 2. Check valves.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Access Doors (if necessary).

1.3 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide Manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welder’s certification of compliance with ASME SEC 9 and AWS D1.1.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.4 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section “Closeout Procedures.”
- B. Record actual locations of valves.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience.

- B. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.
- C. Welders: Certify in accordance with ASME SEC 9 and AWS D1.1.
- D. Pressed Pipe Fittings: Submit documentation of fitting-manufacturer training of installers or their on-site supervisors, with names of individuals.

1.7 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.1 HEATING WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53, Schedule 40, black.
 1. Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding type fittings.
 2. Joints: Schedule 40 threaded for pipe sizes 2" and smaller, and AWS D1.1, welded for pipe sizes 2 1/2" and larger.
 3. Grooved and Shouldered Pipe End Couplings: As specified in this Section, with grooved steel pipe, is an acceptable alternate to the above for water service operating at temperatures from -30⁰ F to +230⁰ F, utilizing grade E, EPDM gasket compound.
- B. Copper Tubing: ASTM B88, Type L hard drawn.
 1. Allowed only for pipe sizes 2" and smaller.
 2. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 3. Joints: Solder or braze, or press fittings.

- C. Stainless Steel Pipe with Press Fittings: See paragraph titled “Press Fittings and Stainless Steel Piping Systems” in this Section.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder or braze, or press fittings.

2.3 BRAZING MATERIALS - 15% Silver for copper, brass, and bronze

- A. Manufacturers:
 - 1. Harris (Product: Stay-Silv 15).
 - 2. Lucas-Milhaupt (Product: Sil-Fos 15).
 - 3. Wolverine (Product: Silvaloy 15).
 - 4. No substitutions.
- B. Nominal Composition: 5.0% phosphorus, 15.0% silver, 0.15% other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 - 1. Color: Yellow/Gray
 - 2. Solidus: 1190°F (643°C)
 - 3. Liquidus: 1480°F (802°C)
 - 4. Brazing Range: 1300 - 1500°F (704-816°C)
 - 5. Electrical Conductivity: 9.9% IACS
 - 6. Electrical Resistivity: 17.40 Microhm-cm
- D. Specification Compliance:
 - 1. ANSI/AWS A5.8, class BCuP-5
 - 2. ASME SFA5.8, class BCuP-5
 - 3. Optional:
 - a. QQB 650C, class BCuP-5
 - b. QQB 654A, class BCuP-5
 - c. QQB 654, class BCuP-5
- E. Flux:
 - 1. Harris (Stay-Silv For copper-to-brass joints. No flux required for copper-to-copper joints).

2.4 BRAZING MATERIALS - 35% Silver for brazing to ferrous metals (steel)

- A. Manufacturers:
 - 1. Harris (Product: Safety-Silv 35).
 - 2. Lucas-Milhaupt (Product: Braze 351).
 - 3. Wolverine (Product: Silvaloy A-35).
 - 4. No substitutions.
- B. Nominal Composition: 35.0% silver, 33% Zinc, 0.15% other elements (total), remainder copper. Cadmium-free.

- C. Physical Properties:
 1. Color: Yellow/Gray
 2. Solidus: 1250°F (677°C)
 3. Liquidus: 1410°F (732°C)
 4. Electrical Conductivity: 19.8% IACS
 5. Electrical Resistivity: 8.2 Microhm-cm
- D. Specification Compliance:
 1. ANSI/AWS A5.8, class BAg-5
 2. ASME SFA5.8, class BCuP-5
- E. Flux:
 1. Harris (Stay-Silv white flux, or where heating cycles are extended, Stay-Silv black flux).

2.5 SOLDER MATERIALS:

- A. Manufacturers:
 1. Harris (Product: Stay-Brite).
 2. Lucas-Milhaupt (Product: Clean 'n Brite).
 3. Wolverine (Product: Silvabrite).
 4. No substitutions.
- B. Nominal Composition: Alloy of silver and tin (3-6% Ag, remainder Sn). Antimony-free.
- C. Physical Properties:
 1. Color: Bright Silver
 2. Solidus: 430°F (221°C)
 3. Liquidus: 430°F (221°C)
 4. Electrical Conductivity: 16.4% IACS
 5. Shear Strength: 10,600 psi (73 MPa)
 6. Tensile Strength: 14,000 psi (96 MPa)
 7. Elongation: 48%
- D. Specification Compliance:
 1. NSF 51
 2. ASTM B32-89, Alloy Grade Sn96
 3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
 4. J-STD-006, Sn96Ag04A
- E. Flux:
 1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4" or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
 2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.6 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 Inches (50 mm) and Under:
 1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.

- B. Flanges for Pipe Over 2 Inches (50 mm):
 - 1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene or EPDM, reinforced as required for the system operating pressure, up to relief valve setting.

- C. Grooved and Shouldered Pipe End Couplings:
 - 1. Approved Manufacturers:
 - a. Victaulic Company.
 - b. Anvil International (division of Mueller Water Products, Inc.) - Gruklok product line.
 - c. Grinnell Mechanical Products (division of Tyco Fire Suppression & Building Products Co.).
 - d. No Substitutions.
 - 2. Products:
 - a. Housing Clamps: Malleable iron to engage and lock, designed to permit some angular deflection, contraction, and expansion.
 - b. Sealing Gasket: C-shape EPDM elastomer composition for operating temperature range from -30°F (-34°C) to 230°F (110°C). This is the standard gasket material suitable for water and glycol service. For other services, verify material.
 - c. Accessories: Steel bolts, nuts, and washers with zinc plating.
 - 3. Note: Grooved couplings are not allowed where concealed above hard ceilings.

- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.7 PIPE HANGERS AND SUPPORTS

- A. Approved Manufacturers (first manufacturer is basis of design):
 - 1. Strut Hangers:
 - a. Unistrut (division of Tyco).
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Hydra-Zorb Company.
 - e. Thomas & Betts - Superstrut line.
 - f. Tolco (division of Nibco).
 - 2. Adjustable Swivel Band Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 3. Clevis Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 4. J-Hangers:
 - a. Carpenter & Paterson.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).

- e. Unistrut (division of Tyco).
 - 5. Roof Support Blocks/Non-Penetrating Roof-Mounted Pipe Support System:
 - a. Cooper B-Line - Dura-Blok line.
 - b. Miro Industries.
 - c. Unistrut (division of Tyco) - Unipier line.
 - 6. Cushion Clamps:
 - a. Hydra-Zorb Company.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).
 - e. Unistrut (division of Tyco).
 - 7. Insulated Pipe Couplings:
 - a. Klo-Shure Corporation.
 - b. Cooper B-Line - Armafix line.
 - 8. No substitutions.
-
- B. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, and MSS SP89 as applicable.
 - C. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
 - D. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
 - E. Hangers for Hot Pipe Sizes 2 to 4 Inches (50 to 100 mm): Carbon steel, adjustable, clevis.
 - F. Hangers for Hot Pipe Sizes 5 Inches (125 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
 - G. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - H. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
 - I. Wall Support for Pipe Sizes to 3 Inches (76 mm): Cast iron hook.
 - J. Wall Support for Cold Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 - K. Wall Support for Hot Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
 - L. Vertical Support: Steel riser clamp.
 - M. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - N. Floor Support for Hot Pipe Sizes to 4 Inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - O. Floor Support for Hot Pipe Sizes 5 Inches (125 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

- P. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- Q. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- R. Inserts: Malleable iron case of 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.

2.8 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

2.9 VALVES

- A. Manufacturers:
 1. Nibco.
 2. Apollo.
 3. Armstrong.
 4. Hammond.
 5. Victaulic Company.
 6. Watts.
 7. Wheatley.
 8. No substitutions.
- B. Ball Valves:
 1. Up To and Including 2 Inches (50 mm):
 - a. Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle, solder or threaded ends.
 - b. 150 lb S.W.P., 600 lb W.O.G.
 2. Over 2 Inches (50 mm):
 - a. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, flanged.
 - b. 150 lb S.W.P., 285 lb W.O.G.
 3. Polypropylene Valves for Polypropylene Piping: May be used instead of standard ball valves.
 - a. Manufacturer: Aquatherm, Greenpipe product line, no substitutions.
 - b. Material: Polypropylene body and handle.
 - c. Up to and including 2-1/2 inch (75 mm) size: Integral union ends, tee handle.
 - d. Over 2-1/2 inches: Flange ring ends, lever handle.
 4. Stem Extensions: Provide ball valves in insulated piping with stem extensions to allow for continuous thickness of field-installed insulation.
- C. Swing Check Valves:
 1. Up To and Including 2 Inches (50 mm): Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
 2. Over 2 Inches (50 mm): Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.
- D. Spring Loaded Check Valves: Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION

- A. Install in accordance with Manufacturer's instructions.
- B. Install heating water piping to ASME B31.9.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls and floors:
 - 1. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
 - 2. Extend sleeves through floors as follows: In locations not otherwise indicated, 2 in. (50 mm) above finished floor level. In normally-dry locations such as finished office spaces under fintube and baseboard radiation, 1 in. (25 mm) above finished floor level. Finished floor level includes the thickness of floor finish materials such as carpet and tile. Caulk sleeves full depth and provide floor plate.
 - 3. Where piping passes through floor, ceiling or wall, close off space between pipe sleeve and construction with non-combustible insulation or with approved firestopping material when penetrating fire rated floors, ceilings or walls. Provide tight fitting metal escutcheons on both ends of sleeves to prevent movement of sleeve during piping expansion. Escutcheons shall be sized slightly larger than outside diameter of piping and smaller than diameter of sleeve. Escutcheons shall be rigidly secured to walls.
 - 4. Where piping passes through fire rated floors, ceilings or walls, close off space between pipe insulation and sleeve with approved firestopping material
 - 5. Install chrome-plated escutcheons where piping passes through finished surfaces.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Division 23 Section "Expansion Fittings and Loops for HVAC"
- H. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- I. Pipe Hangers and Supports:
1. Install in accordance with ASTM B31.9, ASTM F708 and MSS SP89.
 2. Provide in accordance with ASTM B31.9 and MSS SP69 unless indicated otherwise.
 3. Support horizontal piping as scheduled.
 4. Install hangers to provide minimum 1/2-inch (13 mm) space between finished covering and adjacent work.
 5. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 6. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 7. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 8. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 9. Provide copper plated hangers and supports for copper piping.
 10. Prime coat exposed steel hangers and supports. Refer to Division 09 - Painting. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 11. Provide steel angles, unistrut and associated accessories as required to support piping located between building structural members. Install in accordance with accepted industry standards.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Division 23 Section "HVAC Piping Insulation."
- K. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08 Section "Access Doors and Frames."
- L. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- N. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 09 Section "Painting."
- O. Install valves with stems upright or horizontal, not inverted.
- P. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- Q. Grooved Mechanical Couplings:
1. Use grooved mechanical couplings and fasteners in accessible locations only. Grooved mechanical couplings are not allowed in areas such as behind sheetrock walls and above sheetrock ceilings.

2. Install in strict accordance with manufacturer's instructions. Nothing in this Specification is intended to supersede manufacturer's instructions and recommendations.
 3. Prepare pipe ends properly, and check again before coupling installation.
 4. Lubricate gaskets as recommended. Check gasket before installation.
 5. Do not lubricate coupling mating surfaces (bolt pads) or bolt threads, because this might affect torque readings.
 6. Verify that pipe-end separation (all couplings) and deflection from centerline (flexible couplings only) do not exceed manufacturer's specifications. For piping which will operate at a colder temperature than installation temperature (for example, chilled water systems), butt pipes together to provide maximum contraction capability. For piping which will operate at a warmer temperature (for example, heating systems), separate pipe ends the maximum allowed amount to provide maximum expansion capability. Some systems operate at mixed temperatures (for example, cooling tower condenser water systems) and may require different spacing for different sections of the system, and/or a spacing somewhere between minimum and maximum in proportion to the need for expansion and contraction.
 7. NOTE: Tighten nuts evenly by alternating sides until tightened to recommended torque. Make sure the housings' keys completely engage the grooves. Make sure the offsets are equal at the bolt pads, during tightening and when fully tightened. NOTE: It is important to tighten nuts evenly to prevent gasket pinching.
 - a. Victaulic Couplings: On rigid couplings with angled bolt pads, pads will be offset when tightened. On flexible couplings, bolt pads will be in contact and aligned when tightened.
 - b. Anvil and Grinnell Couplings: On rigid couplings, bolt pads will have up to 1/16-inch (1.59 mm) gap when tightened. On flexible couplings, bolt pads will be in contact when tightened.
 8. If an impact wrench or other power tool is used to tighten, use extra care. NOTE: Anvil International does not recommend use of impact wrenches with their Gruvlok products.
 9. For couplings with manufacturer torque specifications, verify torque on each bolt. Do not exceed torque specification by more than 25%.
- R. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- S. Dissimilar Metals: Use non-conducting dielectric connections whenever jointing dissimilar metals. Cast red-brass (not yellow brass) or bronze-bodied fittings such as valves and couplings may be used when joining steel to copper, steel to stainless steel, or copper to stainless steel. Steel and stainless steel may connect directly to iron, but copper may not connect directly to iron.
- T. Valve Type Selection:
1. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
 2. Use ball valves for throttling, bypass, or manual flow control services.
 3. Use Bronze Ball Valves for general shut-off service in heating system piping 2" (50.8 mm) and smaller and at heating terminal units 2" (50.8 mm) and smaller, including fin-tube radiation, unit heaters, convectors and fan coil units.
 4. Use Combination Balancing, Flow Measuring and Tight Shut-off Valves at terminal heating and cooling units, zone branches and as indicated.
 5. Use Bronze Ball Valves for drain valves with hose connections. Provide valve of size indicated; if size isn't indicated, provide at least 3/4" (19 mm) valve size. Provide outlet

fitting for standard “garden hose” with 3/4" (19 mm) hose threads. Provide brass cap with retainer chain. Compression-type “boiler drain valves” are not allowed.

- U. With the exception of valves which must be properly sized to ensure design flow rates (such as balancing valves), valves shall be line sized.
- V. Install concealed pipes close to building structure to keep furring to a minimum.
- W. Slope water piping 1 inch in 40 feet (1:480) and arrange to drain at low points. Slope piping up in direction of water flow.
- X. On closed systems, equip low points with 3/4" (19 mm) drain valves and hose nipples. Provide, at high points of mains, collecting chambers and high capacity float operated automatic air vents. Provide, at high points of branches, manual air vents with air chambers.
- Y. Use main sized saddle type branch connections for directly connecting branch lines to mains in steel piping if main is at least one pipe size larger than the branch for up to 6" (152 mm) mains and if main is at least two pipe sizes larger than branch for 8" (203 mm) and larger mains. Do not project branch pipes inside the main pipe.
- Z. Make connections to equipment and branch mains with unions.
- AA. Pipe used shall be new material, and threads on piping shall be full length and clean cut with inside edges reamed smooth to full inside bore.
- BB. Caulking of threads will not be allowed on any piping.
- CC. Pipe joint compound shall be put on male threads only.
- DD. In the erection of mains, special care must be used in the support, working into place without springing or forcing, and proper allowance made for expansion.
- EE. Pipes shall be anchored, guided, and otherwise supported, where necessary, to prevent vibration or to control expansion.
- FF. Make such offsets as are shown and required to place the pipes and risers in proper position to avoid other work.
- GG. Install a sufficient number of unions or flanged fittings to facilitate making possible future alterations or repairs.
- HH. Erect piping to provide for the easy passage and noiseless circulation of water under working conditions.
- II. Where welded joints are required, steel piping shall be installed by the use of the oxyacetylene or electric welding process, except immediate connections to accessible equipment may be threaded. Piping shall have butt welds with welding fittings, standard factory fabricated tees, elbows, reducers, caps, and accessories. Branch outlets 2" (50.8 mm) and smaller shall be made by the use of approved welding type 1/2 couplings, “Weldolet” or “Threadolet” fittings.
 - 1. Piping smaller than 2" (50.8 mm) may be installed at the Contractor’s option with welding type, or threaded type fittings, except that piping regardless of size concealed in trenches or

- inaccessible building construction (for example, concealed behind sheetrock walls or concealed above sheetrock ceilings) shall be welded.
2. Offsets shall be installed with long radius welding elbows.
 3. Welding shall be executed only by certified welding mechanics in accordance with the best practice of the trade.
- JJ. Take branch lines off bottom of mains or at 45 degree bottom angle, as space permits.
- KK. Minimum pipe size allowed for hydronic piping shall be 3/4" (19 mm). Piping less than 3/4" (19 mm) shall not be allowed for these piping systems.
- LL. For isolation valves, control valves and balancing valves located above suspended ceilings and in areas that are not visible to building occupants (for example, mechanical rooms), provide yellow colored surveyors tape. Permanently attach tape to valve handles and run tape down to 10 inches (254 mm) above ceiling or 12 inches (305 mm) below valve handle where ceilings do not exist (for example, mechanical rooms).
- MM. Standard details for heating and cooling coils are based on single coil arrangements. For heating and cooling coils that are supplied in a split coil arrangement, with 2 or more individual coils, provide additional piping and balancing valves at each coil to ensure that flow through each coil is proportional to the percentage of total coil face area that the coil occupies.

3.3 CLEANING

- A. After satisfactory completion of pressure tests, before permanently connecting equipment, strainers, and the like, clean equipment thoroughly, blow and flush piping for a sufficient length of time as directed, so that interiors will be free of foreign matter. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.
- B. Fill, vent and circulate the system with approved solution in accordance with equipment (boiler, piping, coils, and others) manufacturer's recommendation, allowing it to reach design or operating temperatures. After circulating for 6 hours, drain the system completely and remove and clean strainer screens. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.
- C. Fill and vent system as required.
- D. Manually vent heat transfer units and high points of the system.
- E. Adjust the pressure reducing valve to provide minimum of 5 psig (35 kPa) pressure at the highest point of the system.
- F. After system has been completely filled, start zone pumps and circulate cold water for a short time to dislodge small air bubbles, and return them to air extraction device.
- G. Raise water temperature to 200°F (93°C) while operating pumps.
- H. Stop pump and vent radiation and high points of the system. Normal operation may now be started at any time.

3.4 TESTING

- A. No joint or section of piping shall be left untested.
- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, and other parts which are not designed to stand test pressures.
- C. Test piping for leaks under 100 psig (689 kPa) air pressure with soap suds prior to hydrostatic testing.
- D. Test piping hydrostatically to 1-1/2 times the maximum systems operating pressure, but in no case to less than 75 psig (517 kPa), for at least 4 consecutive hours, during which time pressure shall remain constant without pumping.
- E. Test and obtain Architect's approval before painting, covering, or concealing piping, including swing joints.

3.5 SCHEDULES

- A. Pipe Hanger Spacing:

PIPE SIZE		HANGER ROD MAX. HANGER SPACING		HANGER ROD DIAMETER	
Inches	(mm)	Feet	(m)	Inches	(m)
Steel, and Copper Piping					
1/2 to 1- 1/4	12 to 32	6.5	2	3/8	9
1-1/2 to 2	38 to 50	10	3	3/8	9
2-1/2 to 3	62 to 75	10	3	1/2	13
4 to 6	100 to 150	10	3	5/8	15

END OF SECTION 232113

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SECTION 232118 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air vents.
- B. Strainers.
- C. Flow controls
- D. Balancing valves.

1.2 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.3 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section “Closeout Procedures.”

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”
- B. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section “Product Requirements.”
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.1 AIR VENTS

- A. Float Type:
 - 1. Manufacturers:
 - a. Braukman
 - b. American Amtrol Model 732
 - c. Approved equal.
 - 2. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.2 STRAINERS

- A. Manufacturers:
 - 1. Sarco.
 - 2. Armstrong.
 - 3. Barnes and Jones.
 - 4. Bell & Gossett.
 - 5. Flo-Fab.
 - 6. Keckley Co.
 - 7. Muesco.
 - 8. Wheatley.
- B. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
- C. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged iron body for 175 psig (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.
- D. Size 5 inch (125 mm) and Larger: Flanged iron body for 175 psig (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.

2.3 FLOW CONTROLS

- A. Manufacturers:
 - 1. Tour-Anderson.
 - 2. Taco.
 - 3. Approved equal.
- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psig (24 kPa).
- D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.4 BALANCING VALVES.

- A. Manufacturers:
 - 1. Tour-Anderson.
 - 2. Taco.
 - 3. Approved equal
- B. Valves shall conform to one of the following:
 - 1. Fixed-Orifice Manual Balancing Valve: Calibrated, ball type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer with memory stop. Readout valves measure the pressure differential across the fixed orifice plate or venturi. Valve shall be designed for positive shut-off.
 - 2. Variable-Orifice Manual Balancing Valve: Cast iron or bronze, globe style, balance valve with handwheel with vernier type ring setting and memory stop, readout valves equipped with integral check valves and gasketed caps. Readout valves measure the pressure differential across the variable opening between valve plug and valve seat. Valve shall be designed for positive shut-off. Drain valve may be furnished with this valve, and if positioned properly may be substituted for the separate drain valve indicated. [Caution if using this type valve: Because of hard ceilings throughout the building, valves must be inside the enclosure of most terminal heating units. Ensure that the valve can be installed concealed from view.]
- C. Size balancing valves to allow a reading of 2 to 5 ft wg (6 to 15 kPa) pressure drop at design flow rates. Submittals shall include a chart of valve selections, indicating room number, terminal heating device tag, flow rate, pressure drop, and differential pressure reading.
- D. Insulation: Valves may be furnished with prefabricated thermal insulation. Flame spread reading shall be 25 or less per ASTM E84. R-value shall be 4 hr-sq.ft- F/Btu or greater. Install in accordance with Division 23 Section "HVAC Piping Insulation."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.

- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide valved drain and hose connection on strainer blow down connection.
- F. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove fine-mesh temporary startup strainers after flushing and cleaning systems; hang the startup strainer at the pump to demonstrate to the Engineer that it was removed. If strainer's removable cover is insulated (for example, chilled water systems) the insulation shall be removable and reusable.
- G. Suction diffusers shall have adequate space provided for strainer removal.
- H. Provide combination pump discharge valve (or separate valves, as indicated) on discharge side of base mounted centrifugal pumps.
- I. Provide balancing valves on water outlet from terminal heating units such as radiation, unit heaters, and fan coil units.
- J. Ensure that balancing valves are installed with minimum upstream length of straight pipe as recommended by the manufacturer.
- K. Ensure that balancing valves are installed with the readout valves fully accessible, including space required for insertion of metering probes.
- L. Pipe relief valve outlet to nearest floor drain.
- M. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- N. Standard details for heating coils are based on single coil arrangements. For heating coils that are supplied in a split coil arrangement, with two or more individual coils, provide additional piping and balancing valves at each coil to ensure that flow through each coil is proportional to the percentage of total coil face area that the coil occupies.

END OF SECTION 232118

SECTION 232123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. In-line circulators.

1.2 RELATED SECTIONS

- A. Division 23 Section “Motors, Drives and Accessories.”
- B. Division 23 Section “HVAC Piping Insulation.”
- C. Division 23 Section “Hydronic Piping.”
- D. Division 23 Section “Hydronic Specialties”
- E. Division 26 “Electrical” Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. UL 778 - Motor Operated Water Pumps.
- B. NFPA 70 - National Electrical Code.

1.4 PERFORMANCE REQUIREMENTS

- A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading throughout the entire operating range in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- D. Millwright's Certificate: Certify that base mounted pumps have been aligned.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”

- B. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing, assembly, and field performance of pumps with minimum 3 years' experience.
- B. Alignment: Base mounted pumps shall be aligned by a qualified millwright.

1.8 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pumps, General:
 - 1. Taco.
 - 2. Armstrong.
 - 3. Bell & Gossett.
 - 4. Flo-Fab.
 - 5. Grundfos.
 - 6. Paco.
 - 7. Patterson.
 - 8. Peerless.
 - 9. Weinman.
 - 10. Wilo.
- B. Cartridge Circulators with Integral Speed Controller:
 - 1. Grundfos.
 - 2. Taco
- C. No Substitutions.

2.2 GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless indicated or specified otherwise.
- D. Pump connections shall be flanged.
- E. Wetted parts shall be compatible with circulated fluid.

2.3 CARTRIDGE CIRCULATORS

- A. Type: Cartridge type circulator, in-line mounting, for 125 psig (862 kPa) maximum working pressure, 230 degrees F (110 degrees C) maximum water temperature.
- B. Casing: Cast iron with flanged pump connections.
- C. Impeller: Non-Metallic
- D. Shaft: Ceramic
- E. Bearings: Carbon.
- F. Motor: Impedance protected, single speed, permanent split capacitor.

2.4 CARTRIDGE CIRCULATORS WITH INTEGRAL SPEED CONTROLLER

- A. Grundfos Magna series, with pump-mounted speed controller.
- B. Type: Cartridge type circulator, in-line mounting,
- C. Working Conditions:
 - 1. Working Pressure: 145 psig (10 bar) maximum.
 - 2. Minimum Inlet Pressure: 6.5 psig (0.45 bar) at 194 degrees F (90 degrees C).
 - 3. Fluid Temperature: 230 degrees F (110 degrees C) maximum for short periods, 203 degrees F (95 degrees C) maximum for continuous operation.
 - 4. Ambient Temperature: 32 to 104 degrees F (0 to 40 degrees C).
- D. Casing: Cast iron or stainless steel with flanged pump connections. Wet-varnished finish.
- E. Impeller: Stainless steel, or non-metallic composite.
- F. Shaft: Stainless steel, tungsten carbide, or aluminum oxide.
- G. Bearings: Carbon, with aluminum oxide outer bearing ring, aluminum oxide or silicon carbide inner bearing ring, and stainless steel bearing plate.
- H. Stator Housing: Aluminum, with EPDM O-rings.
- I. Rotor: Permanent-magnet rotor, with leak-proof stainless steel rotor can.
- J. Motor: Variable speed, electronically commutated, synchronous permanent magnet motor, with 3-lead Alpha snap-lock power plug at pump, and flexible power cord for field connection to junction box. Integral motor protection.
- K. Speed Controller: Integral pump-mounted frequency converter. Differential pressure control with "Auto-Adapt" function. Pump speed calculated via a built-in induction coil on the stator winding. Differential-pressure and temperature sensor located inside the pump housing. User interface with LED indicators of relative flow and head, operating mode, on-off status, and fault. Pushbuttons for speed settings and power on-off pushbutton. External start/stop input dry contact. 5 selectable operating modes. Infrared remote control receiver.

- L. Remote Control: Wireless remote control Model R100. Communicates to pump controller via infrared light.
- M. LON Module: Provide module using LonTalk protocol for LONWorks networks, for interface to the building automation system. Module shall provide access to controller information and alarms, allow remote adjustment of setpoints, and allow remote inputs such as start/stop signals. Coordinate requirements with Section 230900.
- N. Insulation Shell: Provide Grundfos Magna insulation shell, factory-molded to the shape of the pump body. Insulation shall be suitable for chilled water service.

2.5 SYSTEM LUBRICATED CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected with multiple speed wet rotor motor for in-line mounting, for 140 psig (965 kPa) maximum working pressure, 230 degrees F (110 degrees C) maximum water temperature.
- B. Casing: Cast iron with flanged pump connections.
- C. Impeller, Shaft, Rotor: Stainless Steel.
- D. Bearings: Metal Impregnated carbon (graphite) and ceramic.
- E. Motor: Impedance protected, single speed

2.6 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psig (1200 kPa) maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Cadmium plated steel, stamped brass or cast bronze, keyed to shaft.
- D. Bearings: 2 oil lubricated bronze sleeves.
- E. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.
- F. Seal: Carbon rotating against a stationary ceramic seat, 225 degrees F (107 degrees C) maximum continuous operating temperature.
- G. Drive: Flexible coupling.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- C. Decrease piping from line size with long radius reducing elbows or reducers.
- D. Pump inlet conditions shall be as recommended by the pump manufacturer to eliminate system effects.
 - 1. Provide suction diffusers where indicated. Suction diffusers shall have adequate space provided for strainer removal. Remove fine-mesh start-up strainers after system startup, and hang adjacent to the pump for Architect/Engineer's approval.
 - 2. Where suction diffusers are not indicated, provide proper straight lengths of inlet piping and long-radius elbows at pump inlets.
- E. Support piping adjacent to pump such that no weight is carried on pump casings. Provide necessary brackets or hanger supports as required to relieve the stress on the pumps and piping. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches (102 mm) and over.
- F. Provide line sized shut-off valve and strainer on pump suction, and properly sized soft seat check valve and balancing/flow-measuring/shutoff valve on pump discharge.
- G. Install pumps with a pressure gauge piped to suction and discharge, with shutoff valves.
- H. Provide air cock and drain connections on horizontal pump casings.
- I. Provide drains for bases and seals, piped to and discharging into floor drains with air gaps.
- J. Lubricate pumps before start-up.
- K. Provide labor and materials required to ensure that pump impellers are adequately sized to provide flow rates as indicated. This shall include, but not be limited to, trimming impellers.

END OF SECTION 232123

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SECTION 232300 – REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and Liquid Indicators.
- D. Valves.
- E. Strainers.
- F. Check Valves.
- G. Pressure Relief Valves.
- H. Filter-Driers.
- I. Solenoid Valves.
- J. Expansion Valves.
- K. Receivers.
- L. Flexible Connections.

1.2 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with MSS SP69 unless indicated otherwise.
- C. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. If receiver is provided, install in liquid line leaving receiver.
 - 3. Use line size on leaving side of liquid solenoid valves.
- D. Valves:
 - 1. Use service valves on suction and discharge of compressors.
 - 2. Use gauge taps at compressor inlet and outlet.
 - 3. Use gauge taps at hot gas bypass regulators and at filters and filter driers, inlet and outlet.
 - 4. Use check valves on compressor discharge.
 - 5. Use check valves on condenser liquid lines on multiple condenser systems.

- E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- F. Strainers:
 - 1. Use line size strainer upstream of each automatic valve.
 - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
 - 3. On steel piping systems, use strainer in suction line.
 - 4. Use shut-off valve on each side of strainer.
- G. Pressure Relief Valves: Use on ASME receivers and on compressors converted to higher pressure refrigerant. Pipe field-installed valves and valves furnished with equipment to outdoors as required by ASHRAE Standard 15 and where directed.
- H. Permanent Filter-Driers:
 - 1. Use in low temperature systems.
 - 2. Use in systems utilizing hermetic compressors.
 - 3. Use filter-driers for each solenoid valve.
- I. Replaceable Cartridge Filter-Driers:
 - 1. Use vertically in liquid line adjacent to receivers.
 - 2. Use with filter elements in suction line. Provide temporary wax removal filter-drier core in low temperature systems and systems where motor failure has occurred.
 - 3. Use filter-driers for each solenoid valve.
- J. Solenoid Valves:
 - 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
 - 2. Use in liquid line of single or multiple evaporator systems.
 - 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- K. Receivers:
 - 1. Use on systems 5 tons (18 kW) and larger, sized to accommodate pump down charge.
 - 2. Use on systems with long piping runs.
- L. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.3 SUBMITTALS

- A. Submit under provisions of Division 01 Section "Submittal Procedures."
- B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- C. Product Data: Provide general assembly of specialties, including manufacturer's catalog information. Provide manufacturer's catalog data including load capacity.

- D. Pipe Sizing Recommendations of Equipment Manufacturers:
 - 1. Verify indicated pipe sizes with the manufacturers of the associated equipment. If manufacturer's recommendations differ from the sizes indicated on the Drawings, submit recommendations to the Architect. The Architect will make the final determination of pipe sizes. Provide sizes per final determination at no additional cost to the Owner. In sizing piping, include modifications as required to affected items including but not limited to piping, valves, filters, other pipeline accessories, insulation, supports, sleeves, conduits, building openings, and building enclosures.
 - 2. Submission of manufacturer's recommendations, and equipment performance related to pipe sizing, is the Contractor's responsibility.
 - 3. Verify sizing prior to any preparation for piping installation.
- E. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- F. Test Reports: Indicate results of leak test, acid test.
- G. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- H. Submit welders' certifications of compliance with AWS D1.1., and their assigned identification letters, numbers or symbols.

1.4 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Closeout Procedures."
- B. Record exact locations of equipment and refrigeration accessories on record drawings.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."
- B. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.6 QUALIFICATIONS

- A. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.
- B. Design piping system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the place where the Project is located.

1.7 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.

- C. Welders Certification: In accordance with AWS D1.1. and state and local requirements.
- D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.
- E. Refrigerant Safety: Conform with ASHRAE 15, state and local codes and manufacturer's requirements for safe handling to avoid exposure to workers or to occupants.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Deliver and store piping and specialties in shipping containers with labeling in place.
- C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- D. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.9 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Division 01 Section "Closeout Procedures."
- B. Provide two refrigeration oil test kits, each containing everything required to conduct one test.
- C. Provide two filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.1 PIPING

- A. Copper Tubing: ASTM B280, Type ACR hard drawn, degreased, nitrogen charged and sealed. Annealed (soft) tubing may be used only for underfloor or below grade runs or for short (6 feet or less) above-grade connections to valves and equipment.
 1. Fittings: ASME B16.22 wrought copper.
 - a. Fittings shall be packaged and labeled for ACR use.
 - b. Elbows: Use long-radius elbows wherever possible. Do not use 45-degree elbows, because they are more likely to break at their inner surface in refrigeration service.
 2. Joints:
 - a. Braze, 15% silver for copper, brass, and bronze.
 - b. Braze, 35% silver, for brazing to ferrous metals (steel).
 - c. Solder (for use only at equipment and valve connections where required by the equipment manufacturer).
 - d. Other: If a valve or equipment manufacturer recommends a joint material other than those specified, submit it for approval.
 - e. Flux: Use as recommended by alloy manufacturer. Should not be needed for copper-to-copper brazed joints.

- B. Copper Tubing to 7/8 inch (22 mm) OD: ASTM B88, Type K, annealed.
 - 1. Fittings: ASME B16.26 cast copper.
 - 2. Joints: Flared.

2.2 PIPE SUPPORTS AND ANCHORS

- A. Approved Manufacturers (first manufacturer is basis of design):
 - 1. Strut Hangers:
 - a. Unistrut (division of Tyco).
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Hydra-Zorb Company.
 - e. Thomas & Betts - Superstrut line.
 - f. Tolco (division of Nibco).
 - 2. Adjustable Swivel Band Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 3. Clevis Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 4. J-Hangers:
 - a. Carpenter & Paterson.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).
 - e. Unistrut (division of Tyco).
 - 5. Roof Support Blocks/Non-Penetrating Roof-Mounted Pipe Support System:
 - a. Cooper B-Line - Dura-Blok line.
 - b. Miro Industries.
 - c. Unistrut (division of Tyco) - Unipier line.
 - 6. Cushion Clamps:
 - a. Hydra-Zorb Company.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).
 - e. Unistrut (division of Tyco).
 - 7. Insulated Pipe Couplings:
 - a. Klo-Shure Corporation.
 - b. Cooper B-Line - Armafix line.
 - 8. No substitutions.
- B. Conform to MSS SP69.
- C. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring.
- D. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

- E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- G. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
- H. Vertical Support: Steel riser clamp.
- I. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- J. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- K. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- L. Inserts: Malleable iron case of 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.
- M. Struts: Provide equal to Unistrut where required. Cadmium or electro-zinc plating is suitable for dry indoor locations only.
- N. Finish for Outdoor or Wet Locations: Hot dip galvanized, stainless steel or epoxy painted. Provide copper plating where metal is in contact with copper pipe.
- O. Support Size: Size to fit outside the pipe insulation.
- P. Cushion Clamps: Hydratorb, for use with bare pipes mounted on struts.

2.3 BRAZING MATERIALS - 15% Silver

- A. Manufacturers:
 1. Harris (Product: Stay-Silv 15).
 2. Lucas-Milhaupt (Product: Sil-Fos 15).
 3. Wolverine (Product: Silvaloy 15).
 4. No substitutions.
- B. Nominal Composition: 5.0% phosphorus, 15.0% silver, 0.15% other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 1. Color: Yellow/Gray
 2. Solidus: 1190°F
 3. Liquidus: 1480°F
 4. Brazing Range: 1300 - 1500°F
 5. Electrical Conductivity: 9.9% IACS
 6. Electrical Resistivity: 17.40 Microhm-cm
- D. Specification Compliance:
 1. ANSI/AWS A5.8, class BCuP-5
 2. ASME SFA5.8, class BCuP-5

3. Optional:
 - a. QQB 650C, class BCuP-5
 - b. QQB 654A, class BCuP-5
 - c. QQB 654, class BCuP-5

- E. Flux:
 1. Harris (Stay-Silv For copper-to-brass joints. No flux required for copper-to-copper joints).

2.4 BRAZING MATERIALS - 35% Silver

- A. Manufacturers:
 1. Harris (Product: Safety-Silv 35).
 2. Lucas-Milhaupt (Product: Braze 351).
 3. Wolverine (Product: Silvaloy A-35).
 4. No substitutions.
- B. Nominal Composition: 35.0% silver, 33% Zinc, 0.15% other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 1. Color: Yellow/Gray
 2. Solidus: 1250°F (677°C)
 3. Liquidus: 1410°F (732°C)
 4. Electrical Conductivity: 19.8% IACS
 5. Electrical Resistivity: 8.2 Microhm-cm
- D. Specification Compliance:
 1. ANSI/AWS A5.8, class BAg-5
 2. ASME SFA5.8, class BCuP-5
- E. Flux:
 1. Harris (Stay-Silv white flux, or where heating cycles are extended, Stay-Silv black flux).

2.5 SOLDER MATERIALS:

- A. Manufacturers:
 1. Harris (Product: Stay-Brite).
 2. Lucas-Milhaupt (Product: Clean 'n Brite).
 3. Wolverine (Product: Silvabrite).
 4. No substitutions.
- B. Nominal Composition: Alloy of silver and tin (3-6% Ag, remainder Sn). Antimony-free.
- C. Physical Properties:
 1. Color: Bright Silver
 2. Solidus: 430°F
 3. Liquidus: 430°F
 4. Electrical Conductivity: 16.4% IACS
 5. Shear Strength: 10,600 psi
 6. Tensile Strength: 14,000 psi

7. Elongation: 48%

D. Specification Compliance:

1. NSF 51
2. ASTM B32-89, Alloy Grade Sn96
3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
4. J-STD-006, Sn96Ag04A

E. Flux:

1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4" or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.6 REFRIGERANTS AND LUBRICANTS

A. Refrigerant: ASHRAE 34;

1. R-410a: Blend of R-32/125.

B. Oils and Other Lubricants: Provide as required by the refrigerant manufacturer and the equipment manufacturer(s).

2.7 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:

1. Sporlan Valve Co, Model "See-All".
2. Emerson Climate Technologies.
3. Henry Technologies.
4. Mueller.

B. Indicators: Double port type, UL listed, with steel body, flared or copper plated solder ends, leak proof fused sight glass, replaceable color coded paper moisture indicator and plastic cap; for maximum working pressure of 500 psig for connection sizes 1-1/8 inch O.D. and smaller, 430 psig for sizes 1-3/8 inch O.D. and larger, and maximum temperature of 200°F. Synthetic gaskets are not allowed.

2.8 VALVES

A. Diaphragm Packless Valves:

1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
2. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psig and maximum temperature of 275°F.

B. Packed Angle Valves:

1. Manufacturers:
 - a. Henry Technologies.

- b. Mueller.
- c. Superior.
- 2. Forged brass (or brass and copper), forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psig and maximum temperature of 275°F.

C. Ball Valves:

- 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
- 2. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig and maximum temperature of 325°F.

D. Service Valves:

- 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
- 2. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig.

2.9 CHECK VALVES

A. Globe Type:

- 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
- 2. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 500 psig and maximum temperature of 300°F.

B. Straight Through Type:

- 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.

- C. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psig and maximum temperature of 250°F.

2.10 EXPANSION VALVES

A. Manufacturers:

- 1. Sporlan.
- 2. Henry Technologies.
- 3. Parker Hannifin.

- B. Angle or Straight Through Type: ARI 750; balanced port or two-port design suitable for refrigerant, brass body, flare or solder connections, internal or external equalizer, resealable bleed hole, adjustable superheat setting, replaceable inlet strainer, with replaceable thermostatic power element with capillary tube and remote sensing bulb. Joints to the body at the removable power element and at the strainer shall be knife-edge type not requiring a synthetic seal.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10⁰ F. superheat. Select to avoid being undersized at full load and excessively oversized at part load. Select thermostatic charge for the particular application.

2.11 ELECTRONIC EXPANSION VALVES

- A. Manufacturers:
 1. Sporlan.
 2. Henry Technologies.
 3. Parker Hannifin.
- B. Valve:
 1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
 2. Capacity: To meet the load of the equipment served.
 3. Electrical Characteristics: Compatible with the control system.
- C. Evaporation Control System:
 1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.
 2. Electrical Characteristics: Compatible with the control system.
- D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.12 PRESSURE REGULATORS

- A. Manufacturers:
 1. Sporlan.
 2. Parker Hannifin.
- B. Brass body, stainless steel diaphragm, pilot operated with internal pressure pilot, adjustable over 0 to 100 psig range, for maximum working pressure of 450 psig.

2.13 PRESSURE RELIEF VALVES

- A. Manufacturers:
 1. Henry Technologies.
 2. Mueller.
 3. Superior.

- B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard setting; selected to ASHRAE 15.

2.14 SOLENOID VALVES

- A. Manufacturers:
 - 1. Sporlan.
 - 2. Henry Technologies.
 - 3. Parker Hannifin.
- B. Valve: ARI 760, pilot operated, brass or steel body and internal parts, teflon seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem shall have a knife-edge joint to the body and shall permit manual operation in case of coil failure.
- C. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.
- D. Electrical Characteristics: 10 to 15 watts, voltage compatible with control system, single phase, 60 Hz.

2.15 FILTER-DRIERS

- A. Replaceable Cartridge Angle Type:
 - 1. Manufacturers:
 - a. Sporlan, Model CW Catch-All.
 - b. Emerson Climate Technologies.
 - 2. Shell: ARI 710, UL listed, steel with epoxy paint finish, copper sweat fittings, removable cap with zinc-plated fasteners, for maximum working pressure of 500 psig, size as recommended by manufacturer.
 - 3. Suction Filter Cartridge: Pleated media with integral end rings, stainless steel support, ARI 730 rating for capacity of the equipment served.
 - 4. Filter/Dryer Cartridge: Pleated media with solid core molecular sieve with activated alumina, ARI 730 rating for capacity of the equipment served.
 - 5. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets, with filter surface area, desiccant volume and ARI 710 moisture rating as recommended by the manufacturer based on line size and refrigeration system horsepower (kW).
- B. Permanent Straight Through Type:
 - 1. Manufacturers:
 - a. Sporlan, Model CW Catch-All.
 - b. Emerson Climate Technologies.
 - 2. ARI 710, UL listed, steel shell with copper plated steel sweat or flare fittings, molded molecular sieve/activated alumina desiccant filter core, for maximum working pressure of 500 psig.
 - 3. Rating: ARI 730 flow capacity of the equipment served.

2.16 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Metraflex.
 - 2. Mason Industries.
 - 3. Keflex.
- B. Corrugated bronze hose with single layer of exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 500 psig.

2.17 RECEIVERS

- A. Manufacturers:
 - 1. Henry Technologies.
 - 2. Refrigeration Research Inc.
 - 3. Sporlan.
 - 4. Standard Refrigeration Co.
- B. Internal Diameter 6 inch and Smaller: ARI 495, UL listed, steel, brazed; 400 psig maximum pressure rating, with tappings for inlet, outlet, liquid level gauge, sight glasses and pressure relief valve. Provide at least two (2) bullseye liquid level sight glasses. Size receiver to hold at least 120% of fully charged system.
- C. Internal Diameter Over 6 inch: ARI 495, welded steel, tested and stamped in accordance with ASME SEC 8D; 400 psig with tappings for liquid inlet and outlet valves, pressure relief valve, sight glasses and magnetic liquid level indicator. Provide at least two (2) bullseye liquid level sight glasses. Size receiver to hold at least 120% of fully charged system.

2.18 STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Sporlan.
 - c. Superior.
 - 2. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psig.
- B. Straight Line, Non-Cleanable Type:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - 2. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 430 psig.
- C. Screens: 80 mesh (0.007 in. square openings) in most uses, 60 mesh (0.010 in.) square openings) in line sizes above 1-1/8 inch, and 40 mesh (0.015 in. square openings) for use in suction lines.

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. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel or perpendicular to building structure, and maintain gradient.
- C. Install annealed piping free of kinks, and with bends only as necessary.
- D. Install PVC conduit joints per ASTM D 2855, and handle cement per ASTM F402. Prime joints, apply a full coat of cement, insert piping while cement is wet, and rotate at least 1/4 turn to spread cement. Conduit shall be watertight.
- E. Install piping to conserve building space and not interfere with use of space.
- F. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of, or recessed into and grouted flush with, slab.
- I. Pipe Hangers and Supports:
 - 1. Install in accordance with MSS SP89.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 7. Provide copper plated hangers and supports for copper piping when hanger must contact the piping.
 8. Provide cushion clamps when bare pipes (pipes on which insulation is not specified) are use with strut hangers or vertical risers.
- J. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required.
- K. Pipe Sleeves and Escutcheons:
1. Provide sleeves, sized to fit outside the pipe insulation with at least 1/4" clearance, at penetrations of building assemblies. Interrupt insulation where required by fire ratings.
 2. Extend floor sleeves to 2 in. above finished floor and seal watertight.
 3. For below-grade penetrations and where indicated, provide watertight link-type pipe seals.
 4. Secure sleeves in place, and caulk, grout or firestop into the building assembly.
 5. Provide split chrome or painted escutcheons where exposed to occupancy.
- L. Provide clearance for installation of insulation and access to valves and fittings.
- M. Provide access to concealed valves and fittings.
- N. Flood piping system with nitrogen when brazing.
- O. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- P. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting.
- Q. Insulate piping and equipment; refer to Division 23 Section "HVAC Piping Insulation."
- R. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- S. Provide liquid line replaceable cartridge (unless sealed type is indicated) filter-driers, with isolation valves and valved bypass. On low temperature systems, or after a hermetic motor burnout, provide wax removal cores. Provide upstream and downstream pressure-testing access valves.
- T. Provide suction line replaceable cartridge filters, with isolation valves and valved bypass. Provide upstream and downstream pressure testing access valves. On low temperature systems, or after a hermetic motor burnout, provide temporary wax removal cores. After cleanup of the system, replace cores with filter elements for lower pressure drop.
- U. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- V. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- W. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- X. Fully charge completed system with refrigerant after testing.

- Y. Provide electrical connection to solenoid valves. Refer to Division 26.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 01 Section “Quality Requirements.”
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig pressure using electronic leak detector. Test to no leakage.
- D. Evacuate the system as required by Codes and by equipment manufacturer, including a vacuum test at 0.02 inches of mercury. The system shall be valved off and tested for 2 hours with a pressure rise of no more than 0.002 inches of mercury.

3.4 SYSTEM STARTUP

- A. Lubricate motors and other moving parts as necessary before operating them.
- B. Charge the system with liquid refrigerant into the low pressure side of the system, where the liquid will evaporate. Expel air from the system. Operate the compressor, condenser, water cooling pumps and evaporator fans during charging. Monitor compressor discharge pressure. Monitor oil levels for a period of 24 hours.
- C. Coordinate control setpoints and wiring prior to startup.
- D. Change suction filter elements if the pressure drop exceeds 1 Psi after the initial 24 hours of operation. Change suction wax removal cores to filter elements after system cleanup.
- E. Adjust expansion valve superheat using a thermistor or thermocouple temperature sensor at the bulb location and a pressure gauge at the external equalizer line (or the compressor). Adjust under full system load, and again when the system stabilizes.
- F. Check the system again after seven full days of operation.
- G. Periodically clean strainers until no more accumulation occurs.

3.5 SCHEDULES

- A. State and Local Codes: If code requirements are more stringent than those indicated herein, provide as required by code.

B. Pipe Hanger Spacing:

PIPE SIZE		HANGER ROD MAX. HANGER SPACING		ROD DIAMETER	
Inches	mm	Feet		Inches	
3/8 to 1-1/4	9 to 32	6.5		3/8	
1-1/2 to 2	38 to 50	10		3/8	
2-1/2 to 3	62 to 75	10		1/2	

END OF SECTION 232300

SECTION 232500 – HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning of piping systems.

1.2 RELATED SECTIONS

- A. Division 23 Section “Instrumentation and Control for HVAC.”
- B. Division 26 “Electrical”: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- D. Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”
- B. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience. Company shall have local representatives with water analysis laboratories and full time service personnel.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years’ experience and approved by manufacturer.

1.7 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for discharge to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for 1-year from Date of Substantial Completion.
- B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit 2 copies of field service report after each visit.
- C. Provide laboratory and technical assistance services during this maintenance period.
- D. Include 2-hour training course for Owner's operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Schedule the course at Owner's convenience after start-up of systems.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.9 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Division 01 Section "Product Requirements."
- B. Provide sufficient chemicals for treatment and testing during warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Chemical Treatment Systems Products, and Services:
 - 1. Barclay Water Management, Inc., Watertown, MA office.
 - 2. Nalco Company, Windham, ME office.
- B. Chemical Treatment Products:
 - 1. Nu-Calgon.
 - 2. Culligan.
 - 3. H-O-H Water Technology, Inc.
 - 4. Wesco Chemicals, Inc.

2.2 MATERIALS

A. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
2. Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

B. Closed System Treatment (Water):

1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
2. Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazone, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.2 CLEANING SEQUENCE

A. Concentration:

1. As recommended by manufacturer.
2. 1 pound per 100 gallons (1 kg per 1000 L) of water contained in the system.
3. 1 pound per 100 gallons (1 kg per 1000 L) of water for hot systems and 1 pound per 50 gallons (1 kg per 500 L) of water for cold systems.
4. Fill steam boilers only with cleaner and water.

B. Hot Water Heating Systems:

1. Apply heat while circulating, slowly raising temperature to 160 degrees F (71 degrees C) and maintain for 12 hours minimum.
2. Remove heat and circulate to 100 degrees F (37.8 degrees C) or less; drain systems as quickly as possible and refill with clean water.
3. Circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.

D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

- E. Remove, clean, and replace strainer screens.
- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

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

3.4 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.

END OF SECTION 232500

SECTION 233113 – METAL DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flexible Ductwork.
- B. Metal Ductwork.
- C. Kitchen Hood Ductwork.
- D. Air Duct Leakage Tests.

1.2 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes is permitted except by written permission from the Architect. Size proposed substitutions of round ducts in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.3 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures”.
- B. Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration. Submit prior to start of work.
- C. Product Data: Provide data for duct materials, duct liner and duct connectors.

1.4 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section “Closeout Procedures.”
- B. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Indicate additional fittings used.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA HVACDCS.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.7 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A and NFPA 90B standards.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures during and after installation of duct sealants.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flexible Ducts:
 - 1. Flexible Technologies Group - Thermaflex product line.
 - 2. Buckley Associates - Flexmaster Triple-Lock Buck Duct product line.
 - 3. No substitutions.
- B. Plastic Drawbands:
 - 1. Panduit.
 - 2. Thomas and Betts.
 - 3. Tyton.
- C. Tape for Flexible Ducts:
 - 1. Ideal Tape Co., division of American Biltrite Inc.
 - 2. 3M Company.
 - 3. Nashua Tape Products, division of Berry Plastics Corp.
 - 4. Venture Tape Corporation.
 - 5. No substitutions.
- D. Glass Fiber Reinforced Plastic Ducts:
 - 1. Spunstrand Inc.
 - 2. Perry Fiberglass Products Inc.
- E. Manufactured Ductwork - Round and Flat Oval:
 - 1. McGill AirFlow LLC, a subsidiary of United McGill Corporation.
 - 2. Aero Heating & Ventilating, Inc.; Portland, ME.
 - 3. Air Purchases, Inc.; Manchester, NH – spiral duct lengths.
 - 4. Atlantic Air Products LLC; Bow, NH.
 - 5. Central City Sheet Metal; Brewer, Caribou, and Gorham, ME.
 - 6. Hahnel Brothers; Bangor and Lewiston, ME.
 - 7. Hranec Corporation; Uniontown, PA.
 - 8. Lindab, Inc. – duct fittings only.
 - 9. Monroe Metal Mfg. Inc.; Monroe, NC.
 - 10. Northeastern Sheet Metal Inc.; Goffstown, NH.
 - 11. Semco Inc., division of the Flakt Woods Group.
 - 12. S.G. Torrice Co.; Wilmington, MA – spiral duct lengths.

13. Sheet Metal Connectors Inc.; Minneapolis, MN.
14. Spiral Manufacturing Co. Inc.; Minneapolis, MN.
15. Total Air Supply; Nashua, NH – spiral duct lengths.
16. No substitutions.

F. Manufactured Ductwork - Transverse Duct Connection System:

1. Ductmate.
2. HFC Enterprises; Baldwin Park, CA – Dura Flange product line, for round and flat oval ducts only.

G. Manufactured Ductwork - Kitchen Hood Single-Wall Grease Duct:

1. Ampco, a division of Hart & Cooley Inc.
2. CaptiveAire.
3. Grease Master.
4. Metal-Fab Inc.
5. Schebler Chimney Systems, a division of The Schebler Co.
6. Selkirk.

H. Manufactured Ductwork - Kitchen Hood Double-Wall Grease Duct:

1. Ampco, a division of Hart & Cooley Inc.
2. CaptiveAire.
3. Metal-Fab Inc.
4. Schebler Chimney Systems, a division of The Schebler Co.
5. Selkirk.

I. Sealants:

1. Hardcast, a division of Carlisle Corporation.
2. Approved equal.

2.2 MATERIALS

A. Galvanized Steel Ducts:

1. Steel sheet metal components of galvanized ductwork in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating (G90 minimum for outdoor or moist applications) conforming to ASTM A653 rating system and tested in accordance with ASTM A90.
2. Provide paint-grip exterior surfaces for exposed ducts, where available.
3. Sheet metal gauge shall be not less than 26 gauge (0.56 mm).

B. Carbon Steel Ducts: ASTM A1008, A1011. Also known as black iron.

2.3 FLEXIBLE DUCTS

A. Insulated Flexible Ducts:

1. Semi-Rigid Flexible Aluminum Ductwork:
 - a. Flexmaster Triple-Lock Buck Duct - Insulated.
 - b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
 - c. Fiberglass insulation and fire-retardant polyethylene vapor retarder film.

- d. Pressure Rating: 12 inches WG (2988 Pa) positive for all sizes, 12 inches WG (2988 Pa) negative for sizes thru 16" diameter (406 mm), 8 inches WG (1992 pa) negative for sizes 18" (457 mm) and 20" (508 mm).
 - e. Maximum Velocity: 5500 fpm (27.9 m/sec).
 - f. Inside bend radius: Minimum one diameter.
 - g. Temperature Range: -40°F to 250°F (-40°C to 121°C).
 - h. UL 181, Class 0 air duct.
 - i. Meets NFPA 90A and 90B standards.
2. Fabric-Core Flexible Ductwork:
- a. Thermaflex Model M-KC.
 - b. Greenguard certified.
 - c. UL 181, Class 1, heavy fiberglass cloth fabric supported by helically wound spring steel wire; fiberglass insulation; reinforced metalized vapor barrier film.
 - d. Pressure Rating: 10 inches WG (2.5 kPa) positive and 2.0 inches (500 Pa) negative.
 - e. Maximum Velocity: 6000 fpm (30.4 m/sec).
 - f. Temperature Range: -20°F to 250°F (-28°C to 121°C).
- B. Non-Insulated Flexible Ducts:
1. Semi-Rigid Flexible Aluminum Ductwork:
- a. Flexmaster Triple-Lock Buck Duct - Bare.
 - b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
 - c. Pressure Rating: 12 inches WG (2988 Pa) positive for all sizes, 12 inches WG (2988 Pa) negative for sizes thru 16" diameter (406 mm), 8 inches WG (1992 pa) negative for sizes 18" (457 mm) and 20" (508 mm).
 - d. Maximum Velocity: 5500 fpm (27.9 m/sec).
 - e. Inside bend radius: Minimum one diameter.
 - f. Temperature Range: -40°F to 250°F (-40°C to 121°C).
 - g. UL 181, Class 0 air duct.
 - h. Meets NFPA 90A and 90B standards.
- C. Return and Exhaust: Use either semi-rigid flexible aluminum type (insulated or bare), or fabric-core type (insulated). Non-insulated fabric-core type does not have adequate negative pressure rating.

2.4 ACCESSORIES

- A. Drawbands for Flexible Ducts:
- 1. Stainless Steel: 1/2-inch (13 mm) wide with screw-driven worm gear.
 - 2. Plastic: Panduit PLT5H or PLT8H; Thomas and Betts Dukt-Rap, VAL-26-50, or VAL-275X-25; or Tyton T150L or LX. Install with manufacturer's lever-action tightening tool.
- B. Tape for Flexible Ducts: Ideal-Seal 587A/B, UL 181B-FX listed, aluminum foil with pressure-sensitive acrylic adhesive, -20°F to 250°F (-28°C to 121°C) temperature range, 25.0 lb/in. width (109.4 N/25.4 mm width) tensile strength.
- C. Fasteners: Rivets, bolts, or sheet metal screws.
- D. Sealants: See Duct Sealant portion of this Specification.

- E. Hanger Rod: ASTM A36; galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.5 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVACDCS, as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. SMACNA Duct Construction Manuals:
 - 1. The SMACNA recommendations shall be considered as mandatory requirements.
 - 2. Substitute the word "shall" for the word "should" in these manuals.
 - 3. Where the Contract Specifications differ from SMACNA recommendations, the more stringent requirements (as determined by the Architect) shall take precedence.
 - 4. Details on the Contract Drawings take precedence over SMACNA standards.
- C. Sheet metal shall be galvanized steel as specified in Part 2 paragraph "Materials" in this Section, unless otherwise indicated or specified.
- D. Construct Tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
 - 1. Where space is too restricted for full-radius elbows, provide mitered (square-throat) elbows with single wall turning vanes. Do not use air foil turning vanes.
 - 2. Mitered elbows in round or flat-oval ductwork shall be factory-manufactured.
 - 3. Radiused elbows with throat radius 1/2 times width of duct (centerline radius 1 width of duct) may be used instead of mitered elbows, but only where space is too restricted for full radius.
 - 4. Fittings not conforming to these requirements will be ordered removed and replaced with proper fittings.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence or convergence (per side) wherever possible; maximum 30 degrees divergence (per side) upstream of equipment and 45 degrees convergence (per side) downstream.
- F. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch (100 mm) cemented slip joint, brazed or electric welded. Prime coat welded joints.
- G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- H. Longitudinal locks or seams known as "button-punch-snap-lock" and other "snap-lock" types will not be permitted in rectangular duct. Snap-lock longitudinal seams may be used on round ducts up to 8 inches diameter, with screws provided to secure the seams at 24 inches on center maximum spacing.
- I. Exposed Ducts: Select and handle materials with care for a neat appearance. Joint connections on round and flat oval ducts shall be sleeve or flanged type; drawbands are not acceptable.

2.6 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufactured ductwork and fittings listed below are acceptable alternatives to standard ductwork systems. For exposed round and flat oval ductwork, factory-manufactured ductwork and fittings are required.
- B. Manufacture in accordance with SMACNA HVACDCS, and as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- C. Exposed Round and Flat Oval Ductwork: Shall be manufactured ductwork by one of the listed manufacturers.
 - 1. Spiral Ductwork Acceptable Products:
 - a. McGill Airflow: Standard Uni-Seal product line (smooth surface between spiral lockseams) or Uni-Rib product line (one standing seam reinforcement between each pair of spiral lockseams).
 - b. Monroe Metal Inc.: Standard spiral product line (smooth surface between spiral lockseams). V-Rib product line is not allowed.
 - c. Other Manufacturers: Standard spiral product line (smooth surface between spiral lockseams).
 - d. Ductwork and fittings shall be products of a single manufacturer.
- D. Exposed Ducts:
 - 1. Select and handle materials with care for a neat appearance.
 - 2. Joint connections on round and flat oval ducts shall be sleeve or flanged type; drawbands are not acceptable. Joint connections on flat oval ducts 42 inches and wider shall be flanged type to ensure tight fit and good appearance.
 - 3. Provide exterior reinforcing only where required, with prior approval from the Architect.
 - 4. External reinforcement of flat-oval ducts shall be full-perimeter angle rings. Straight angles along flat sides only are not allowed.
- E. Galvanized and stainless steel sheet metal used in fabrication shall be not less than 26 gauge thickness. Aluminum shall be not less than 0.025 in. nominal thickness. This requirement supersedes SMACNA requirements.
- F. Round and Flat Oval Duct and Fittings:
 - 1. Shall be suitable for at least 4 in. WG positive pressure and 2 in. WG negative pressure in accordance with SMACNA HVACDCS standards. This is a minimum; provide higher ratings where required.
 - 2. Fittings shall be fabricated of sheet metal at least one gauge heavier than straight duct of the same size.
 - 3. Fittings shall be factory-sealed so that no field sealing of joints between gores or segments is required. Acceptable methods of construction are fully welded, spot-welded with inner sealant, or standing-seam crimped joints.
- G. Radiused Elbows in Round and Flat Oval:
 - 1. In exposed ductwork shall be non-adjustable type, factory-sealed.
 - 2. In concealed ductwork may be adjustable type, with full long radius as detailed on the Drawings. Short-radius elbows are not allowed.

3. Shall be constructed of the following minimum number of segments or gores: 90-degree: 4 gores; 60-degree: 3 gores; 45-degree: 3 gores; 30-degree: 2 gores; 22-1/2-degree: 2 gores.
 4. 1-piece stamped elbows are acceptable up to 12 inches diameter. Pleated elbows are acceptable up to 10 inches diameter.
- H. Mitered Elbows in Round and Flat Oval:
1. Available in both 90-degree and 45-degree elbows.
 2. Shall have minimum number of welded single-wall vanes as follows (size is duct width in plane of bend):
 - a. 3 to 9 inch: 2.
 - b. 10 to 14 inch: 3.
 - c. 15 to 19 inch: 4.
 - d. 20 to 60 inch: 5.
 - e. Larger Sizes: 12-inch maximum spacing.
- I. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.
- J. Flat Oval Ducts: Machine made from round spiral lockseam duct.
- K. Double Wall Insulated Flat Oval Ducts: Machine made from round spiral lockseam duct, galvanized steel outer wall, 1 inch (25 mm) thick fiberglass insulation, perforated galvanized steel inner wall; fittings manufactured with solid inner wall. Joint connections shall be flanged type; sleeve type or drawbands are not acceptable.
- L. Transverse Duct Connection System: SMACNA "F" rated or SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips. Product shall be Ductmate factory-manufactured connectors, or field-formed flanges using a specialized machine.

2.7 KITCHEN GREASE HOOD EXHAUST DUCTWORK

- A. Fabricate in accordance with SMACNA HVACDCS and NFPA 96.
- B. Construct of 16 gauge (1.50 mm) carbon steel or 18 gauge (1.21 mm) type 304 or 316 stainless steel, using continuous external welded joints. Ductwork exposed to view or exposed to weather shall be stainless steel unless otherwise indicated.
- C. Gaskets and sealants shall be rated for 1500 degrees F (815.6 degrees C) continuous operation.
- D. Connection to Fan: Provide transition plate to fan base, of same material as duct. Outer perimeter shall be full size of fan base or curb. Inner opening shall be same size as duct and similar to fan inlet size. Inner opening shall be centered in plate to align with fan inlet and to maintain clearances. Duct shall be welded smoothly and continuously to the transition plate, preferably butt-welded to the underside of the plate or with plate corners turned down into duct, rather than duct turned out onto plate. Provide a smooth flat surface for installation of high-temperature gasket between transition plate and fan base. Fasten transition plate to the roof curb.
- E. Elbows:
 1. Mitered: Internal turning vanes are not allowed. Mitered elbows should be avoided in grease

- ducts except where indicated.
2. Radiused: Provide full radius (centerline radius 1-1/2 times the duct width), continuously curved for rectangular duct, gored for round duct. In manufactured round duct, elbows may be manufacturer's standard, with throat radius as little as 6 inches (75 mm).
- F. Factory-manufactured single-wall grease duct may be used where single-wall round duct is indicated.
1. The system shall be UL Classified in accordance with UL 1978.
 2. The factory-built grease duct system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
 3. The system shall be designed to compensate for thermal expansion.
 4. The single wall exhaust shall be of type 430 stainless steel. Minimum steel thickness shall be 18 gauge.
 5. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.
 6. The entire system from outlet to the termination, including accessories and support brackets, except as noted, shall be from the manufacturer. Access doors may be the product of other manufacturers.
 7. The diameter for the exhaust shall be verified by the manufacturers' computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
 8. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
 9. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.
- G. Factory-Manufactured Double-Wall Grease Duct with Zero Clearance to Combustibles:
1. Products:
 - a. Ampco - Model IVSI-4ZC.
 - b. Captive-Aire – Model DW-3Z (available diameters 8 to 24 in. (203 to 609 mm).
 - c. Metal-Fab - Models 3G and 4G.
 - d. Schebler - FyreGuard.
 - e. Selkirk - ZeroClear.
 2. The system shall be UL Classified in accordance with UL 1978 and UL 2221.
 3. The system shall be rated for zero clearance to combustibles.
 4. The outer shell shall have a 2 hour fire rating, as an integral enclosure eliminating field-built enclosures.
 5. The system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
 6. The system shall be designed to compensate for thermal expansion.
 7. The inner wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 18 gauge.
 8. The outer wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.024 inch (24 gauge) (0.61 mm) on diameters up to 24 inches (609 mm), 0.035 inch (20 gauge) (0.89 mm) on diameters up to 36 inches (914 mm), and 0.048 inch (18 gauge) (1.21 mm) on larger sizes.
 9. The integral interstitial insulation shall be heavy-duty high-temperature blanket type. Thickness 3 or 4 inches (75 or 100 mm) as required for UL classification. The insulation shall be attached to the inner duct wall using metal bands and fasteners.
 10. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.
 11. Provide hood transitions, roof support section, and fan adapter.
 12. The entire system from outlet to the termination, including access doors, accessories and support brackets, except as noted, shall be from the manufacturer.
 13. The diameter for the exhaust shall be verified by the manufacturers' computations. The

- computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
14. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
 15. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.
- H. Factory-Manufactured Double-Wall Grease Duct with $\frac{3}{4}$ inch (19 mm) Clearance to Combustibles:
1. Products:
 - a. Captive-Aire – Model DW-2R (available diameters 8 to 24 in. (203 to 609 mm).
 - b. Products of other manufacturers which are listed for zero clearance may be substituted. These products have thicker insulation and require additional space for installation, which is the Contractor’s responsibility to provide.
 - 1) Ampco - Model IVSI-4ZC.
 - 2) Metal-Fab - Models 3G and 4G.
 - 3) Schebler - FyreGuard.
 - 4) Selkirk - ZeroClear.
 2. The system shall be UL Classified in accordance with UL 1978 and UL 2221.
 3. The system shall be rated for $\frac{3}{4}$ inch (19 mm) clearance to combustibles, measured from the duct outer shell.
 4. The outer shell shall have a 2 hour fire rating, as an integral enclosure eliminating field-built enclosures.
 5. The system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
 6. The system shall be designed to compensate for thermal expansion.
 7. The inner wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 18 gauge.
 8. The outer wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.024 inch (24 gauge) (0.61 mm) on diameters up to 24 inches (609 mm), 0.035 inch (20 gauge) (0.89 mm) on diameters up to 36 inches (914 mm), and 0.048 inch (18 gauge) (1.21 mm) on larger sizes.
 9. The integral interstitial insulation shall be heavy-duty high-temperature blanket type. Thickness 2 or 3 inches (50 or 75 mm) as required for UL classification. The insulation shall be attached to the inner duct wall using metal bands and fasteners.
 10. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.
 11. Provide hood transitions, roof support section, and fan adapter.
 12. The entire system from outlet to the termination, including access doors, accessories and support brackets, except as noted, shall be from the manufacturer.
 13. The diameter for the exhaust shall be verified by the manufacturers’ computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
 14. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
 15. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.

2.8 PRESSURE CLASSIFICATION

- A. Ratings as indicated on the Drawings or as specified. See Ductwork Pressure Class Schedule in Part 3 of this Section.

- B. If no ratings are indicated, ductwork shall be rated for the external static pressure of the system plus twenty-five percent.
 - 1. If 4 dampers (of any type) or fewer can isolate a duct system, that portion of the system shall be rated for the shut-off pressure of the system fans.

2.9 DUCT SEALING

- A. Seal ductwork as outlined in the SMACNA HVACDCS. Seal ductwork to a minimum of class A (transverse joints, longitudinal seams, and duct wall penetrations), regardless of pressure class
- B. Seal ductwork systems as required to ensure that maximum duct leakage does not exceed that allowed by the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual. Allow sealant to dry in accordance with manufacturer's requirements of time and environmental conditions before ductwork systems are pressurized.
- C. Existing Ductwork: Seal existing ductwork served by, and/or connected to, the equipment furnished under Division 23, and ductwork as indicated on the Drawings. Contractor shall be responsible to field-verify quantities and sizes. Provide access to existing ductwork as required for complete sealing. Remove existing finishes and loose existing sealants as required for proper adhesion of sealant.
- D. Duct sealing materials used shall be non-flammable and non-combustible in both liquid and solid states.
- E. Seal exposed ducts by applying mastic-type or gasket-type sealer just before the joint or seam is made; remove excess sealant for a neat appearance.
- F. Fill (with matching duct material such as sheet metal) any gaps in duct which exceed the recommendations of the sealant manufacturer, and in no case shall liquid or mastic sealant be used to fill gaps or openings which exceed 1/8 inch (3.2 mm) in any direction. Verify that system air pressure acting on a wide gap will not exert enough force to damage or loosen the sealant.
- G. Materials for Sealing:
 - 1. Hardcast: Flex-Grip 550 or Iron-Grip 601 mastic.
 - 2. Hardcast: gypsum-based tape and mastic, waterproof type when used on moist-air exhaust or in humid or outdoor locations.
 - 3. Ductmate: Flanged lateral joints with gaskets.
 - 4. Ductmate: PROseal.
 - 5. Foster: Duct-Fas or Safetee mastic sealant. Duct-Fas is UV resistant and recommended for applications exposed to sunlight.
 - 6. Mon-Eco: Eco-Duct Seal 4450 (red color) or 4452 (grey color). Use grey color where ducts will be unpainted and exposed to public view.
 - 7. Polymer Adhesives Sealant Systems: Airseal No. 11 premium sealant.

2.10 UNIFORMITY OF MATERIALS

- A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install ducts in accordance with SMACNA HVACDCS.
- C. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. "Fishmouth" duct connections are not allowed.
- E. Exposed Ducts:
 - 1. Handle with care for a neat appearance. Repair or replace dented or damaged ductwork as required by the Architect. Select hangers for appearance, and to prevent sagging or distortion of duct.
 - 2. Remove labels attached to ducts before receiving paint.
- F. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot 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.
- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with crimp in direction of air flow.
- I. Use double nuts and lock washers on threaded rod supports. Strap hangers shall be minimum 16-gauge (1.50 mm) x 1-inch (25 mm) galvanized straps. Hanger and support components including but not limited to "unistrut" shall be galvanized steel except that where other duct materials are used, the hanger materials shall be compatible and non-corrosive to the duct. Wire hangers are not acceptable.
- J. Flexible Ducts:
 - 1. Connect diffusers or light troffer boots to low pressure supply ducts directly or with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.
 - 2. Minimum bend radius shall be one and one half times the duct diameter. Support the bend to maintain this radius.
 - 3. Bends shall not exceed 45 degrees.
 - 4. Connect flexible ducts to metal ducts with 2 turns of duct tape and metal draw bands. Plastic drawbands may be used if they are installed using the band manufacturer's lever-action tightening tool. On insulated flexible ducts, provide an additional seal of tape and drawband on the insulation's vapor barrier.
- K. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.

- L. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Do not start ducted air moving equipment until construction is completed to a stage where airborne construction dust is no longer present. At the time of substantial completion, the entire air distribution system shall be turned over to the Owner clear of construction dust and debris. If the interior surfaces of any ducted air moving equipment or the interior surfaces of any portion of the ductwork distribution system are found, as determined by the Architect, to contain significant construction dust and debris, the entire air distribution system shall be cleaned in accordance with Division 23. If proper precautions are taken to prevent construction dust and debris from entering the ductwork during construction and if the Architect finds all ductwork to be free from such dust and debris, air duct cleaning shall not be required.

- M. For fresh air intake and exhaust plenums connected to louvers or brick or block vents, pitch bottom of plenums down to bottom of louver at minimum 1/4" per foot (2 percent). Seal connections and joints on bottom of plenums watertight with mastic. Connect bottom of plenum to top-inside edge of bottom louver blade or waterstop as detailed on the Drawings, to ensure positive drainage

- N. Install duct-mounted components furnished under other Sections of this Specification, such as smoke dampers, control dampers, control sensors, and smoke detectors. Install with straight lengths of duct as required for proper operation. Provide access at such components as required. Install in accessible locations for maintenance; notify the Architect if a location indicated or selected requires addition of access by other trades.

- O. Kitchen Grease Hood Exhaust Ductwork:
 1. Use polished stainless steel for ductwork exposed to view, and stainless steel or carbon steel for ducts where concealed.
 2. Seams, joints, and penetrations shall have a liquidtight continuous external weld.
 3. Connect to hood as required by the Mechanical Code, NFPA 96, and manufacturer's instructions. If a factory raised angle collar is provided with the hood, provide a compatible angle on the duct end, and weld continuously or provide a bolted and gasketed connection to allow disassembly. If no factory collar is provided, insert the duct 1 inch into the hood and weld continuously. Do not field-modify or cut the hood with written permission from the Architect.
 4. At fan, provide a fan adapter of same construction as duct, with flat plate the full size of fan base or curb. Weld duct continuously to the plate, centered to maintain clearances to curb and straight inlet to fan. Provide a smooth flat surface for installation of fan gasket.
 5. Manufactured Ductwork: Install in accordance with manufacturer's instructions.
 6. Ducts shall not pass through fire walls or fire partitions.
 7. Clearances: Maintain minimum 18 inches (460 mm) from ductwork to combustible materials and minimum 3 inches (77 mm) from ductwork to limited combustible materials. Clearances may be reduced in accordance with manufacturer's UL listing for fire-resistive duct wrap, and for factory-manufactured double-wall ductwork.
 8. Provide approved access doors at changes of direction of kitchen exhaust ductwork. Provide nameplate of suitable material on access doors stating "ACCESS PANEL - DO NOT OBSTRUCT". Install access doors on top or sides of duct; in horizontal ducts, locate opening above the bottom of the duct to form a grease dam.
 9. Provide mechanical sealing adapter by Ansul Fire Protection (or equal by Kidde) to allow access by balancing contractor for balancing hood system. Coordinate size of mechanical sealing adapter with balancing contractor. Provide cap for adapter when not in use. Install mechanical sealing adapter in exhaust ductwork as close to exhaust fan as possible.

3.2 SCHEDULES

A. Ductwork Material Schedule

AIR SYSTEM	MATERIAL
Low Pressure Supply (Heating Systems)	Galvanized Steel
Low Pressure Supply (System with Cooling Coils)	Galvanized Steel
Return and Relief	Galvanized Steel
General Exhaust	Galvanized Steel
Outside Air Intake	Galvanized Steel

B. Ductwork Pressure Class Schedule

AIR SYSTEM	SMACNA PRESSURE CLASS
Supply	1 inch (250 Pa)
Return and Relief	1 inch (250 Pa)
General Exhaust	1 inch (250 Pa)
Outside Air Intake	1 inch (250 Pa)
Intake and Exhaust	1 inch (250 Pa)

3.3 AIR DUCT LEAKAGE TESTS

- A. Perform air duct leakage tests in accordance with the testing procedures outlined in the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual.
- B. Leakage testing shall be performed on complete ductwork including fittings and accessories such as dampers, access doors, branch connections, and inlets and outlets. Flexible ducts, VAV boxes, air handling units, and duct coils may be excluded. Ducts may be temporarily sectioned and capped for testing, for reasons of limited test apparatus capacity, or requirements of construction phasing.
- C. Leakage tests, including retests as required, shall be performed prior to concealment and insulation and prior to building occupancy.
- D. The Following Duct Systems Shall Be Tested for Leakage, regardless of whether or not SMACNA recommends testing:
 - 1. Supply ductwork from fan outlet to inlet of VAV boxes and reheat coils
 - 2. Return ductwork from fan inlet to point where ductwork serves fewer than 3 return registers and/or grilles.

- E. Submit testing apparatus, procedures, and preliminary forms prior to performing tests.
- F. Once leakage tests are complete, submit leakage test report. Leakage test report forms shall include the following:
 - 1. Project and system identification data
 - 2. Description of ductwork under test
 - 3. Leakage class specified
 - 4. Test pressure specified
 - 5. Duct construction pressure class
 - 6. Duct design air flow
 - 7. Surface area of ductwork under test
 - 8. Maximum allowable leakage factor
 - 9. Calculated allowable leakage
 - 10. Test apparatus
 - a. Blower
 - b. Orifice, tube size
 - c. Orifice size
 - d. Orifice coefficient
 - e. Calibration date
 - 11. Test orifice differential pressure
 - 12. Leakage for tested section
 - 13. Total leakage for system
 - 14. Date of test
 - 15. Witnesses
- G. Air duct leakage testing shall be performed by an experienced agency that is independent of the Testing, Adjusting and Balancing (TAB) Agency specified in Division 01 - Testing, Adjusting and Balancing.
- H. The TAB Agent shall witness the duct leakage tests performed under Division 23. At a minimum, the first duct leakage test shall be witnessed and approved by the TAB Agent and the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the TAB Agent. The TAB Agent shall confirm proper testing procedures and shall give written approval of the leakage tests. If deficiencies are discovered, the TAB agent shall document these deficiencies to the Contractor and the Engineer. Once deficiencies are corrected, the TAB Agent shall witness follow-up leakage tests.
- I. Coordinate with TAB Agency and receive written sign-off of the leakage tests by the TAB Agent prior to submitting leakage test report.
- a. Leakage Class Schedule:

DUCT PRESSURE CLASS	DUCT TYPE	LEAKAGE CLASS
Below 3 inch W.G.	Rectangular Metal	12
Below 3 inch W.G.	Round Metal	6
3 inch W.G. and above	Rectangular Metal	6
3 inch W.G. and above	Round Metal	3

END OF SECTION 233113

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Dampers:
 - 1. Volume Control Dampers.
- B. Iris Dampers
- C. Duct Access Doors.
- D. Duct Sleeves, Prepared Openings and Closure Collars.
- E. Duct Test Holes.
- F. Flexible Duct Connections.
- G. Turning Vanes.

1.2 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.
- C. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate for fire dampers.

1.3 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section “Closeout Procedures.”
- B. Record actual locations of access doors and test holes.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.5 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Protect dampers from damage to operating linkages and blades.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL

- A. Steel sheet metal components of accessories in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating conforming to ASTM A653 rating system and tested in accordance with ASTM A90. Provide paint-grip exterior surfaces for exposed ducts, where available.

2.2 DAMPERS

A. MANUFACTURERS

1. Ruskin.
2. Air Balance, Inc.
3. Arrow.
4. Cesco.
5. Greenheck.
6. NCA.
7. Tamco.
8. Ventex.
9. Vent Products, Inc.
10. No substitutions.

B. Volume Control Dampers:

1. Factory-fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.
2. Shop fabrication is permitted for single blade dampers and splitter dampers only.
3. Height is the dimension perpendicular to the blade rod or shaft. Width is the dimension parallel to the blade rod.
4. Splitter Dampers:
 - a) Material: Same gage as duct to 24 inches (600 mm) size in either direction, and two gages heavier for sizes over 24 inches (600 mm).
 - b) Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - c) Operator: Minimum 1/4 inch (6 mm) diameter rod in self aligning, universal joint action, flanged bushing with set screw.

5. Single Blade Dampers: For duct sizes (height x width) up to 7 x 30 inch (175 x 760 mm). When height or width exceeds its respective maximum, provide multi-blade damper.
6. Multi-Blade Damper: Opposed blade pattern with maximum blade sizes (height x width) 8 x 72 inch (200 x 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
7. End Bearings: Except in round ductwork 6 inches (150 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings. Provide retainer clips or other devices to prevent bearings from pulling out. For single-blade dampers, plastic bearings are allowed.
 - a) Manufacturers:
 - 1) Duro Dyne.
 - 2) Elgen Manufacturing.
 - 3) Rossi.
 - 4) Ventfabrics.
 - b) Snap-in Plastic Bearings for Single-Blade Dampers: Designed to push into hole in sheet metal, with retaining tabs. Flame Retardant, Glass Reinforced, "Zytel" polymer by Dupont, conforming to UL 1995 and UL 94 with the required flammability rating of 5VA or lower. Acceptable materials include Polyamide 66 (PA66) (glass-reinforced Dupont Zytel), nylon and acetyl. Submit manufacturer's verification of the suitability of these bearings for the application, including operating pressures and temperatures.
8. Quadrants:
 - a) Manufacturers:
 - 1) Duro-Dyne.
 - 2) Elgen Manufacturing.
 - 3) Rossi
 - 4) Ventfabrics.
 - b) Duro-Dyne Specline SR and SRH series; Quadline series; or Stampline dial regulators and wedge-loc regulators. Or equal by Elgen, Rossi, or Ventfabrics. Rossi Everlock regulators shall be acceptable equivalents to Duro-Dyne. Factory-manufactured dampers shall have damper manufacturer's choice of quadrant equal to the Duro-Dyne products specified.
 - c) Provide locking, indicating quadrant regulators on single and multi-blade dampers and splitter dampers. Regulators shall include lever handle, locking wing nut and graduated indicator dial. Provide shaft seals, bushings, or gaskets for duct penetrations. Quadrants without these features are not allowed.
 - 1) Rossi Everlock Regulators: Locking lever handle of Polyamide 66 (PA66) (glass-reinforced Dupont Zytel) plastic, thumb trigger with stainless steel spring, with at least 9 latching positions in a 90-degree rotation.
 - d) On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters, with open space to run insulation through.
 - e) Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends, with a single rod so that either regulator will control the entire damper.
9. Remote Manual Operators:
 - a) Manufacturers:
 - 1) Young Regulator Company.
 - b) Cable Type with Rack and Pinion: Bowden remote cable assembly, including rack and pinion controllers at damper and ceiling, galvanized angle bracket for duct mounting, stainless pull wire with galvanized steel flexible outer casing, and 2-5/8-in. (66 mm) diameter zinc cup with 3-in. (76 mm) diameter cover plate.

- c) Cable Type with Worm Gear Actuator: Model 1200-FS with worm gear operator for duct mounting, flexible shaft, and concealed ceiling cup and cover.
 - d) Rigid Shaft Type with Worm Gear Actuator: 927 or 1200 series worm gear assembly, 301 or 315 series concealed ceiling regulator with cup and cap, and square connecting rod.
 - e) Cover Plate Finish: Selected by Architect, from manufacturer's standard offerings including zinc plated, chrome plated, stainless steel, and primer painted.
10. Provide required operating wrenches for balancing, and furnish to the Owner at project completion.

2.3 IRIS DAMPERS

- A. Manufacturers:
 - 1. Ruskin - VFBD35 Series.
 - 2. Continental Fan Manufacturing Inc. – Iris Series.
 - 3. FanTech - IR Series.
- B. Galvanized steel construction, full circumferential neoprene or EPDM seals to inlet and outlet ducts, 6 CFM (10.2 m³/hr) maximum casing leakage, permanent plastic or metal pressure taps, accuracy +/- 5%. Frame shall fully encapsulate iris blade segments, and have rolled edges for strength. Blade segments shall be internally linked to an adjustment knob or lever with calibrated position indicator. Internal linkage fully encapsulated out of the airstream. Linear response of airflow to damper position. Designed for low self-noise generation.
- C. Blades open fully for duct cleaning. Full airtight closure capability is not required unless indicated on the Drawings.
- D. Installation Note: For precise metering of airflow, the iris damper should be located at minimum 1 diameter before or after an elbow, 3 diameters before a tee, 1 diameter after a tee, and 3 diameters before an outlet register.

2.4 DUCT ACCESS DOORS

- A. Manufacturers of Standard Doors:
 - 1. Ruskin.
 - 2. Air Balance, Inc.
 - 3. Arrow.
 - 4. Cesco.
 - 5. DuctMate.
 - 6. Greenheck.
 - 7. NCA.
 - 8. Vent Products, Inc.
- B. Fabricated in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings. Standard access doors and access doors for grease ducts may be shop-fabricated. Pressure rating shall be equal to the rating of the associated ductwork; see Part 3 Division 23 Section "Metal Ducts" for schedule of pressure classes.

- C. Standard Doors: Removable, with retainer chain. Rigid and close-fitting with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1 inch (25 mm) thick insulation with galvanized steel sheet metal airstream-side cover.
1. 16 inches (406 mm) Square and Smaller: Secure with two sash locks.
 2. Over 16 inches (406 mm), up to 24 inches (610 mm) Square: Provide four sash locks.
 3. Larger Sizes: Hinges and two compression latches with outside and inside handles.
 4. Clamping-type doors with knob handles, as manufactured by Ductmate, may be substituted for standard sizes.
 5. Material: Galvanized steel in galvanized steel ductwork. Stainless steel in stainless steel ductwork. Aluminum as manufactured by Arrow in aluminum ductwork.
 6. Provide in negative-pressure systems, and in positive-pressure systems with specified pressure class at or below 2 in. WG (498 Pa).
- D. Access Doors For Grease Duct Applications:
1. Shop-fabricated:
 - a) Material to match duct.
 - b) High-temperature ceramic gasket, suitable for at least 1500°F (815.6°C).
 2. Ductmate Industries, Inc. HI-TEMP access door, or approved equal.
 - a) 16 gage (1.61 mm) black iron backing plate.
 - b) High temperature ceramic gasket, 2300°F (1260°C) maximum.
 - c) Zinc plated conical springs, zinc coated wing nuts and zinc plated carriage bolts.
 3. Ductmate Industries, Inc. ULtimate or ULtimate II access door.
 - a) UL 1978 Listed.
 - b) UL label and “Do Not Obstruct” label.
 - c) 2 layers of 11 gage metal (provide black iron (carbon steel) or Type 304 stainless to match ductwork).
 - d) High temperature ceramic gasket, 2300°F (1260°C) maximum.
 - e) The ULtimate door is sandwich style, and requires no welding and special tools, but requires extra duct size.
 - f) The ULtimate II door has a welded frame, and is available with or without a piano hinge.
 - g) Collapsible loop handle welded to outer door.
 - h) Corner thumb bolts. ULtimate door has studs with wingnuts welded to inner door.
 - i) Can be used with high temperature insulation.
 4. For factory-manufactured round grease ducts, access doors may be furnished by the duct manufacturer. For double-wall ducts, access doors shall include inner and outer stainless steel and inner layer of insulation.
 5. Duct openings in horizontal ducts shall be above the bottom of duct to form a grease dam.
 6. Meet NFPA 96 requirements for use in grease duct systems.
- E. Access doors with sheet metal screw fasteners are not acceptable.
- F. Sizing: Select sizes to allow testing, service, and maintenance within the ductwork. Such access may require the insertion of one or both hands, arms, and shoulders as appropriate. Doors sized for viewing-only are not acceptable. Doors found to be of inadequate size shall be replaced with proper size.

2.5 DUCT SLEEVES, PREPARED OPENINGS AND CLOSURE COLLARS

- A. Duct Sleeves and Closure Collars: Fabricate from minimum 20-gage (1.0 mm) galvanized steel or equivalent thickness of aluminum, select material to match duct material. Where sleeves are installed in bearing walls, provide structural steel sleeves.
- B. Prepared Openings: Provide 1-inch (25.4 mm) clearance between the duct and the sleeve.

2.6 DUCT TEST HOLES

- A. Manufacturers:
 - 1. Ductmate.
 - 2. Carlyle Corporation.
 - 3. Duro-Dyne.
 - 4. Ventfabrics.
- B. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- C. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.7 FLEXIBLE DUCT CONNECTIONS

- A. Manufacturers:
 - 1. Ductmate.
 - 2. Ventfabrics.
 - 3. Duro-Dyne.
 - 4. No substitutions.
- B. Fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.
- C. Connector: Fabric crimped into metal edging strip.
 - 1. Connectors shall be Ductmate PROFLEX Commercial series.
 - 2. Fabric: UL listed coated woven glass fiber fabric meeting the requirements of NFPA 90A and NFPA 701. Resistant to weather and most chemicals, fat, grease, and oil.
 - a) Supply Ducts: Neoprene coated, minimum density 30 oz per sq yd (1.0 kg/sq m). Fire-retardant coating. Black color. Temperature range -40 to 200°F (-40 to 93°C).
 - b) Exhaust Ducts Serving Fume Hoods: Hypalon coated, minimum density 24 oz per sq yd (0.8 kg/sq m). Flame proof coating. White color. UV and ozone resistant. Temperature range -40 to 250°F (-40 to 121°C).
 - 3. Net Fabric Width: Approximately 3 inches (75 mm) wide.
 - 4. Metal: 3 inch (75 mm) wide, 24 gage (0.6 mm thick).
 - a) Supply Ducts: G-60 galvanized steel.
 - b) Exhaust Ducts Serving Fume Hoods: Type 316 stainless steel.
 - 5. Connectors shall have double fold seams. Single fold seams (metal folded once only) shall not be accepted.

2.8 TURNING VANES

- A. Manufacturers for Turning Vanes and Vane Rails:
 - 1. Ductmate Industries - PROrail 2-inch Turning Vane Rail.
 - 2. Duro Dyne - Junior Vane Rail.
 - 3. Hardcast, a division of Carlisle Corporation - Dyn-O-Rail Jr.
- B. Factory-fabricated and factory-or-field-assembled units consisting of curved turning vanes for uniform air distribution and change of direction with minimum turbulence and pressure loss. Provide curved single thickness vanes for mitered elbows with change in direction of 45 degrees or greater, conforming to SMACNA HVACDCS single vane schedule for small vanes. Each vane shall form a 90-degree arc. Fill the entire duct cross-section with vanes. Orient leading edge of vanes parallel to the side of the duct (directed straight into the entering airstream). Turning vanes shall be minimum 16 gauge (1.61 mm), regardless of gauges that are recommended by SMACNA. Double thickness turning vanes are not allowed.
- C. Turning vanes in rectangular ductwork and shop-fabricated round ductwork shall conform with details on the Drawings. If not detailed, the SMACNA detail for small-radius small-spacing single-thickness vanes shall be used.
- D. Turning vanes in manufactured round and flat oval duct elbows shall be the duct manufacturer's standard size, spacing, and gauge, but must be single-wall and not less than 16 gauge (1.61 mm).
- E. Factory-fabricated turning vane rails shall be a minimum of 24 gauge (0.7 mm) galvanized steel.
- F. Material for vanes and rails shall be the same as the duct sheet metal.

2.9 UNIFORMITY OF MATERIALS

- A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVACDCS. Refer to Division 23 Section "Metal Ducts" for duct construction and pressure class.
- B. Provide duct access doors in horizontal return air, exhaust air and fresh air intake ductwork to facilitate the removal of accumulations of dust and combustible materials in accordance with NFPA 90A. Install access doors at maximum 20 foot (6 m) intervals and at the base of each vertical riser.
- C. Provide duct access doors for inspection, servicing, and cleaning before filters, before and after coils, before and after fans, before automatic dampers, at fire dampers, at smoke dampers, at combination fire and smoke dampers, at smoke detector sampling tubes (upstream of the sampling tube), at multiple blade volume dampers, at backdraft and counterbalanced dampers, and elsewhere as specified or as indicated on the drawings. Provide at changes in direction of kitchen exhaust

ductwork and as otherwise required for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as specified or as indicated on the Drawings. Review locations prior to fabrication.

- D. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- E. Use splitter dampers only where indicated.
- F. Provide balancing dampers on duct take-offs to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly. Where branch duct is completely above non-accessible wallboard ceiling and the Architect has not approved the use of access doors, duct mounted balancing dampers shall not be required.
- G. For volume dampers located above suspended ceilings and in areas that are not visible to building occupants (e.g. mechanical rooms), provide fluorescent orange colored surveyor's tape. Permanently attach tape to damper handles and run tape down to 10 in. (254 mm) above ceiling or 12 in. (304 mm) below damper handle where ceilings do not exist (e.g. mechanical rooms).
- H. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and support by vibration isolators. Staple and seal connections airtight.
- I. Duct Sleeves and Prepared Openings: Install for ducts passing through roofs, ceilings, walls and floors. Field determine the proper size and location of sleeves and prepared openings.
 - 1. Duct Sleeves: Allow one-inch (25 mm) clearance between duct and sleeve or one-inch (25 mm) clearance between insulation and sleeve for insulated ducts, except at grilles, registers, and diffusers.
 - 2. Prepared Openings: Allow one-inch (25 mm) clearance between duct and opening or one-inch (25 mm) clearance between insulation and opening for insulated ducts, except at grilles, registers, and diffusers.
- J. Closure Collars:
 - 1. Provide not less than 4 inches (100 mm) wide on each side of walls or floors where sleeves or prepared openings are installed. Fit collars snugly around ducts. Grind smooth edges of collar to prevent tearing or puncturing insulation covering or vapor barrier.
 - 2. Where insulated ducts penetrate non-fire-rated walls, insulation shall be continuous through the closure collars and the closure collars shall be installed tight to the insulation.
 - 3. Where insulated ducts penetrate fire rated walls, insulate ducts on both sides of closure collars and seal points of contact between closure collar and insulation with vapor proof adhesive.
 - 4. Where ducts penetrate fire rated walls, provide fire proof sealant at closure collar. Refer to Division 07 Section "Through Penetration Firestop Systems," for fire proof sealant requirements.
 - 5. Secure closure collars to ducts with sheet metal screws at maximum 6-inch (152 mm) centers and secure closure collars to walls or floors with sheetrock screws, nails or other appropriate fastener at maximum 6-inch (152 mm) centers.
 - 6. Packing: Pack with non-combustible glass fiber insulation in spaces between sleeve/opening and duct/duct insulation. Cover or seal edges of packing to contain loose fibers.

- K. Duct Hangers and Supports: SMACNA HVACDCS, Section 4. Hang ducts up to and including 36 inches (914 mm) in width by a minimum of 1 in x 16 gage (25 mm x 1.61 mm) flat straps on each side of the duct on 4 ft (1.22 m) centers, bent under bottom of duct a minimum of 2 inches (50 mm) and securely fastened to duct. Hang ducts larger than 36 inches (914 mm) in width by 3/8 inch (9.5 mm) steel rods and 2 x 2 x 1/4-inch (50x50x6.3 mm) steel angle trapeze hangers, spaced 4 ft (1.22 m) on center. Provide seismic restraint complying with SMACNA SRMGMS. Anchor risers in the center of the vertical run to allow ends of riser free vertical movements. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchors from puncturing the metal decking. Where supports are required between structural framing member, provide suitable intermediate metal framing. Where C clamps are used, use retainer clips.
1. Flexible Ducts: Support ducts by hangers every 3 feet (0.9 m), unless supported by ceiling construction. Stretch flexible air ducts to smooth out corrugations, and long radius elbows, where possible, using a minimum length to make connections.
 2. Flexible Connectors: Provide flexible connectors between fans and ducts or casings and where ducts are of dissimilar metals. For round ducts, securely fasten flexible connectors by zinc-coated steel clinch-type draw-bands. For rectangular ducts, lock flexible connectors to metal collars.
 3. Ducts with Extra Weight Such As Lead Lining or Lagging: Include the extra weight in determination of suitable hangers and supports.
- L. Provide duct test holes where indicated and required for testing and balancing purposes.

END OF SECTION 233300

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SECTION 233400 – HVAC FANS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Centrifugal Fans:
 - 1. Backward Inclined Centrifugal Fans.
 - 2. Forward Curved Centrifugal Fans.
 - 3. Airfoil Centrifugal Fans.
 - 4. Inline Centrifugal Fans.
 - 5. Upblast Centrifugal Roof Exhaust Fans for Kitchen Hood Exhaust.
- B. Power Ventilators:
 - 1. Roof Exhausters.
 - 2. Cabinet Exhaust Fans.
- C. Motors and Drives.
- D. Fan Accessories.

1.2 RELATED SECTIONS

- A. Division 23 Section “Motors Drives and Accessories.”
- B. Division 23 Section “Duct Insulation.”
- C. Division 23 Section “Metal Ducts.”
- D. Division 23 Section “Air Duct Accessories”
- E. Division 23 Section “Instrumentation and Control for HVAC”
- F. Division 26 “Electrical.”

1.3 REFERENCES

- A. Division 01 Section “Quality Requirements.”
- B. ANSI/ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- C. ANSI/ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- D. AMCA 99 - Standards Handbook.
- E. AMCA 210 - Laboratory Methods of Testing Fans for Rating.
- F. AMCA 261 - Directory of Products Licensed to Use the AMCA Certified Ratings Seal.

- G. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- I. NEMA MG1 - Motors and Generators.
- J. NFPA 70 - National Electrical Code.
- K. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- L. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease Vapors from Commercial cooking Equipment.
- M. UL 705 - Power Ventilators.
- N. UL 762 - Power Roof Ventilators For Restaurant Exhaust Appliances.

1.4 SUBMITTALS

- A. Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate assembly of fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Division 01 Section “Closeout Procedures”: Procedures for submittals.
- B. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.

1.7 REGULATORY REQUIREMENTS

- A. Kitchen Grease Hood Exhaust Fans: Comply with requirements of NFPA 96.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01 Section “Product Requirements”: Transport, handle, store, and protect products.
- B. Protect motors, shafts, and bearings from weather and construction dust.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 Section “Product Requirements”: Environmental conditions affecting products on site.
- B. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test-run under observation.

PART 2 - PRODUCTS

2.1 ELECTRONICALLY-COMMUTATED (EC) MOTORS - ALSO KNOWN AS BRUSH-FREE DC (BFDC) MOTORS

- A. Manufacturers:
 - 1. Greenheck Fan Corporation - “Vari-Green” motor.
 - 2. General Electric.
 - 3. Twin City Fan Co.
- B. Applications: Ceiling and cabinet fans, centrifugal inline fans, centrifugal roof exhaust fans, and centrifugal upblast exhaust fans, in sizes up to 3/4 hp (0.56 kW). Voltage 115V/1ph/60Hz.
- C. See Division 23 Section “Motors, Drives and Accessories” for general requirements.
- D. Speed Control:
 - 1. Typical motor speed range is 350 RPM to 1725 RPM.
 - 2. Motor operates on a voltage signal of 2-10 VDC, with 15-20 percent speed at 2V and 100 percent speed at 10V. Motor is switched off when the signal is 0-1.9 VDC.
 - 3. Control method furnished with the motor shall be one of the following, as indicated on the Drawings or in the Specifications:
 - a. Motor-mounted potentiometer with screwdriver setting. Provide this unless otherwise indicated or specified.
 - b. Remote-mounted Belimo potentiometer with calibrated 0-100 percent dial. Potentiometer includes a toggle switch to select an output range of 0-10V or 2-10V, so that with the 0-10 V setting the control can turn the fan off. Factory-mounted 24 VDC transformer in a junction box.
 - c. Factory-furnished circuitry to accept a 0-10V signal from the building control system. Requires an additional 24 VDC power supply to the motor’s controls, 0.70 VA capacity.
 - 4. Provide field-furnished metal 2 x 4 in. (50 x 100 mm) junction box for mounting remote potentiometer dials.
 - 5. Provide field-furnished interconnecting power and control wiring as required, including separate flexible conduits for line-voltage and low-voltage wiring.

2.2 UPBLAST CENTRIFUGAL ROOF AND WALL EXHAUST FANS FOR KITCHEN HOODS

- A. Manufacturers:
 - 1. Captive Aire.
 - 2. Loren Cook.
 - 3. Greenheck.
- B. Description: The exhaust fan shall be supplied by the hood manufacturer. The fan shall be belt or direct driven, as scheduled on the Drawings. Base shall be reinforced aluminum construction. Fan housing shall be heavy-duty spun aluminum. The motor compartment shall be isolated and forced cooled by air drawn from outside the fan through breather tubes. The fan shall be U. L. rated under Standard 762 for grease laden vapors. The motor shall be continuous duty type with shielded ball bearings. Belt drives shall be the adjustable speed V-belt type.
- C. Performance:
 - 1. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
 - 2. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
 - 3. Fabrication: Conform to AMCA 99.
 - 4. Performance Base: Sea level conditions.
 - 5. Temperature Limit: Maximum 300 degrees F (150 degrees C)
 - 6. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.
- D. Wheel and Inlet: Backward inclined, aluminum construction with smooth curved inlet, backwardly curved blades, cast aluminum hub keyed to shaft with set screws.
- E. Bearings and Drives:
 - 1. Bearings: Heavy duty cast iron pillow block type, self-aligning, grease-lubricated ball bearings, with ANSI/ABMA 9-rated L-50 life at least 200,000 hours at maximum catalogued operating speed.
 - 2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated.
 - 3. Drive Frame Assembly: Heavy ga steel, mounted on vibration isolators.
 - 4. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp (11.2 Kw) and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 hp (15 Kw) and over. Matched belts. Drive rated as recommended by manufacturer, with minimum 1.5 times nameplate rating of the motor.
- F. Grease Trough: Provide integral trough at base of housing.
- G. Hinged Subbase: Provide with flexible weatherproof electrical cable and service hold-open retainer to permit proper inspection and cleaning.
- H. Roof Curb: Provide factory-fabricated roof curb with proper height (but in no case less than 18 inches (457 mm) high) to ensure 18 inch (457 mm) clearance from fan to combustibles and ensure that the fan discharges a minimum of 40 inches (1016 mm) above the roof surface.
 - 1. Curb shall be constructed of galvanized steel with no insulation or combustible materials, and shall incorporate a field-installed high-temperature non-combustible gasket around

- perimeter top, and be designed for installation on flat roof. Curb shall have ventilation openings where required by Code.
2. Curb shall be installed, shimmed for roof pitch, leveled and flashed by Roofing Subcontractor.

2.3 POWER VENTILATORS

- A. Manufacturers:
 1. Greenheck.
 2. Loren Cook.
- B. Product Requirements:
 1. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
 2. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
 3. Fabrication: Conform to AMCA 99.
 4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- C. Roof Curbs:
 1. Construction: Galvanized steel or aluminum, with continuously welded seams, 1-1/2 in. (38 mm) thick rigid fiberglass insulation with 3.0 lb/cu.ft (48 kg/m³) density and coated for airstream exposure, base flashing flange at least 1-1/8 in. (38 mm) wide, and factory installed wood nailer strip installed with notched and lapped joints for strength. For curbs where duct is not continuous thru the curb (such as curbs with sound baffles), provide metal liner to keep the wood nailer out of the airstream.
 2. Height: For installations where base of curb is under the roof insulation, curb shall be 16 inches (400 mm) high (unless otherwise indicated) with built-in cant strips. For installations where base of curb is not under any roof insulation (but may be under thin roof finish material such as membrane, shingles, or metal roofing), curb shall be at least 12 inches (300 mm) high (unless otherwise indicated) with no cant strips.
 3. Pitched Roof Curbs: Curbs for pitched and double-pitched roofs shall have base with built-in slopes to match roof pitches. Height of these curbs shall be at least the height specified above, measured at the highest point on the sloped base.
 4. Curb Seal: Provide rubber curb seal for installation between curb and equipment.
- D. Roof Exhausters:
 1. Centrifugal Fan Unit: Centrifugal impeller, V-belt or direct driven as scheduled on the Drawings, with spun aluminum housing; resilient mounted motor; 1/2 inch (13 mm) mesh, 0.62 inch (1.6 mm) thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
 2. Sheaves: For v-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

- E. Cabinet Exhaust Fans:
 - 1. Centrifugal Fan Unit: Centrifugal impeller, V-belt or direct driven as scheduled on the Drawings, with galvanized steel housing lined with 1/2 inch (13 mm) acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
 - 2. Vibration Isolation: Provide mounting brackets to accept rubber hangers. Vibration isolators furnished by the fan manufacturer are not allowed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Division 01 Section "Quality Requirements": Manufacturer's instructions.
- B. Install fans with resilient mountings and flexible electrical leads.
- C. Install flexible connections between fan inlet and outlet and ductwork, including roof and wall-mounted fans unless otherwise indicated; refer to Division 23 Section "Air Duct Accessories." Ensure metal bands of connectors are parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.
- D. Secure roof fans with hex-head lag screws to roof curb, minimum of 2 screws on each side of fan, minimum 8 screws total. Screw threads shall be wood type or sheet metal type as appropriate, #12 (7/32 inch (5.6 mm) minimum sheet metal screw size, 3/16 inch (4.8 mm) shank minimum wood screw size. For aluminum fans with aluminum curbs, or steel curbs with wood nailers, use aluminum screws. For aluminum fans with steel curbs (without wood nailers, such as kitchen grease exhaust fans), use galvanized steel screws with rubber or plastic washers to isolate dissimilar metals. For steel fans with steel curbs, use galvanized steel screws.
- E. Extend ducts to into roof curb. Transition ducts to roof curb opening size before penetrating roof.
- F. Hung Cabinet Fans:
 - 1. Install fans with resilient mountings and flexible electrical leads. Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 2. Install flexible connections specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" between fan and ductwork. Ensure metal bands of connectors are parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.
- G. Provide sheaves required for final air balance.
- H. Install motor operated backdraft dampers on inlet to roof exhausters. Dampers shall be sized and installed in ductwork that is full roof curb opening size.
- I. Do not operate fans in normal operation until ductwork is clean, filters are in place, bearings are lubricated, and fan has been test run under observation.

END OF SECTION 233400

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers/Grilles.

1.2 SUBMITTALS

- A. Submit under provisions of Division 01 Section "Submittal Procedures."
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets indicating type, size, application, rated airflow, noise level, pressure drop, and throw distance as applicable. Submit both manufacturer's standard performance tables and graphs, AND tabulated selection data specific to this project. NOTE: Submittals without complete and sufficient information, to verify the performance specified and scheduled on the Drawings, shall be rejected.

1.3 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Closeout Procedures."
- B. Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Diffusers, Registers, Grilles, and Drum Louvers:
 - 1. Titus.
 - 2. Anemostat.

3. Krueger.
4. Metalaire.
5. Price.

B. No substitutions.

2.2 RECTANGULAR CEILING DIFFUSERS

- A. Type: Square and rectangular, multi-louvered directional diffuser to discharge air in pattern as indicated. Removable and interchangeable core for cleaning and changing patterns without tools.
- B. Frame: Surface mount, inverted T-bar, snap-in, or spline type, as indicated and as required to be compatible with ceiling. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel with baked enamel off-white finish.

2.3 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with blades set at 45 degrees, vertical or horizontal face as indicated.
- B. Frame: 1-1/4 inch (32 mm) margin with concealed mounting.
- C. Fabrication: Steel with 20 gauge (0.90 mm) minimum frames and 22 gauge (0.80 mm) minimum blades, steel and aluminum with 20 gauge (0.90 mm) minimum frame, or aluminum extrusions, as indicated, with factory off-white enamel finish.

2.4 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing with spring or other device to set blades, vertical or horizontal face as indicated, double deflection.
- B. Frame: 1-1/4 inch (32 mm) margin with concealed mounting and gasket.
- C. Fabrication: Steel with 20 gauge (0.90 mm) minimum frames and 22 gauge (0.80 mm) minimum blades, steel and aluminum with 20 gauge (0.90 mm) minimum frame, or aluminum extrusions, as indicated, with factory off-white enamel finish.

2.5 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with blades set at 45 degrees, vertical or horizontal face as indicated.
- B. Frame: 1-1/4 inch (32 mm) margin with concealed mounting.
- C. Fabrication: Steel with 20 gauge (0.90 mm) minimum frames and 22 gauge (0.80 mm) minimum blades, steel and aluminum with 20 gauge (0.90 mm) minimum frame, or aluminum extrusions, as indicated, with factory off-white enamel finish.

2.6 CEILING SLOT DIFFUSERS (Equal to Price SDA Series)

- A. Type: Continuous slot of width indicated, with adjustable vanes for left, right, or vertical discharge.
- B. Fabrication: Aluminum extrusions with factory enamel finish, off-white on exposed face, black on interior and pattern vanes.
- C. Frame: 7/8 inch margin with concealed support clips for suspension system mounting and gasket, mitered end border.
- D. Plenum: Integral, galvanized steel, insulated.
- E. Alignment Strips: Provide where 2 or more sections are installed in a continuous line.

2.7 FILTER RETURN GRILLES (For Assembly Hall)

2.8 Shall be equal to Metalaire series SRHF-6 GS with 1" thick throwaway filter. Grille shall be sized for 2' x4' card ceiling surface mounting.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
- C. Install outlets and inlets to ductwork with air tight connection.
- D. Slope ducts or plenums at louvers, and at brick or block vents, to drain outward, and seal bottoms watertight.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Surfaces exposed to view shall be clean, and free of stains, smudges, and scratches.
- G. Provide hex-head fasteners to curb in each hole in curb caps or bases of roof-mounted units. Provide protection between dissimilar metals.

END OF SECTION 233700

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SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

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. Listed concentric vent products.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Building-heating-appliance chimneys.
- B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
 - 2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Welding certificates.
- D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain listed system components through one source from a single manufacturer.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.
- C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Selkirk Saf-T Vent SC
 - 2. Approved equal.

2.2 BREECHING AND CHIMNEY SYSTEM

- A. The entire boiler breeching and chimney system shall be AL 29-4C stainless steel with 409 stainless steel outer jacket concentric vent and air supply system. System shall be UL tested and UL listed (UL 1738) for use with building heating equipment burning gas. Material shall comply with the following:
 - B. Boiler breeching and chimney components, supports and terminations shall be factory prefabricated, and shall be tested and listed by the Underwriters Laboratory, Inc., for use with building heating equipment burning gas.
 - C. The system shall maintain airtight integrity at pressures up to 72 inches of water column.
 - D. Inner pipe joints shall be sealed as specified in the manufacturer's installation instructions.
 - E. The breeching and vent stack shall comply with national Safety Standards and all national and local building codes.
 - F. The entire breeching and chimney system from the boiler to the termination; including accessories, except as noted; shall be from one manufacturer.
 - G. The breeching and chimney system shall be installed according to the manufacturer's installation instructions and shall comply with the local codes or standards.
 - H. Chimney shall terminate at a height of 3'-0" above the finished roof as indicated on drawings, with vent cap.
 - I. The chimney shall be self supporting, without the need for guy wires or intermediate supports, to a maximum of 6'-0" in height.
 - J. When installed according to the manufacturer's installation instructions, the breeching, chimney and its supporting system shall resist side loads (whether system is horizontal or vertical) at

least 1.5 times the weight per foot of the piping. Plate supports shall support (as verified by manufacturer testing) 200 feet of vent stack in 6 inch through 20 inch ID sizes.

- K. Technical Services Support: The factory-built modular breeching and chimney system shall be provided by a vendor organization which assures design, installation and services coordination.
- L. The breeching and chimney shall be warranted against functional failure due to defects in material and manufacturer's workmanship for a period of ten years from date of delivery. The following two actions shall be performed by the Contractor:
 - 1. Drawings showing the actual layout and drawn to scale shall be provided by the manufacturer. The system shall be installed as designed by the manufacturer and in accordance with the terms of the manufacturer's 10 year warranty and in conjunction with sound engineering practice.
 - 2. The inner diameter for breeching and stack system shall be verified by the manufacturer's computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the inner pipe. The contractor shall provide the exact boiler model and operating characteristics to the factory representative. Operating characteristics shall include flue gas flow rate, BTU, input, outlet temperature, local altitude, stack layout, and available external pressure at boiler outlet, etc., necessary to determine system operation at maximum and minimum levels of burner turndown range. Notify the engineer if the manufacturer's calculated inner diameter differs from that indicated.
- M. Accessories, UL labeled:
 - 1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
 - 2. Bellows joint (lined) as required by manufacturer to compensate for linear thermal expansion.
 - 3. Stack Termination Cap Assembly.
 - 4. Accessories as required by the manufacturer for manufacturer approved installation and support of system.
 - 5. Flue transition as necessary from heating appliance to vent material. Contractor to coordinate closely with heating appliance manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Listed, Refractory-Lined Metal Breechings and Chimneys: Freestanding boiler vents, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 54, whichever is most stringent.
- B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate draining into appliance.
- E. Lap joints in direction of flow.
- F. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.
- G. Erect stacks plumb to finished tolerance of no more than 1 inch (25 mm) out of plumb from top to bottom.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

SECTION 235216 - CONDENSING BOILERS

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 packaged, factory-fabricated and assembled, gas-fired, condensing boiler, trim, and accessories for generating heating hot water for the entire facility.

1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Source quality-control test reports.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.
- F. Other Informational Submittals:
 - 1. ASME Stamp Certification and Report: Submit "H" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Condensing Boilers:
 - a. Parts Excluding Heat Exchanger: 2 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Viessmann
 - 2. Buderus
 - 3. Weil-McLain
 - 4. Approved equal

2.2 MANUFACTURED UNITS

- A. Description: Factory-fabricated, assembled and tested, water-jacketed condensing boiler with stainless steel heat exchanger sealed pressure tight, built for wall mounting; including insulated jacket; flue-gas vent; water supply, return, and condensate drain connections; and controls.
- B. Primary Heat Exchanger: Minimum of stainless steel.
- C. Secondary Heat Exchanger: Minimum of copper nickel alloy.
- D. Burner: Natural gas, forced draft.
- E. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.
- F. Ignition: Electric-spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- G. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3. Finish: Powder-coated protective finish.
 - 4. Insulation: Insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connections: Inlet and vent duct collars.
 - 6. Mounting base to secure boiler to wall.

- H. Integrated features:
 - 1. Main gas train.
 - 2. Integrated boiler control.
 - 3. High limit thermostat, manual reset 100 deg F -197 deg F.
 - 4. High exhaust pressure switch, manual reset.
 - 5. Low Water Cut-off, probe type, manual reset.
 - 6. Air switch, differential pressure type.
 - 7. Combustion blower, variable speed.
 - 8. Condensate treatment assembly

2.3 TRIM

- A. Safety Relief Valve: ASME rated.
- B. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- C. Boiler Air Vent: Automatic.
- D. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.

2.4 CONTROLS

- A. Refer to Division 23 Section "Instrumentation and Control for HVAC."
- B. Microprocessor-based combination PID temperature control and flame management.
- C. On-board digital touch-pad user interface.
- D. Boiler operating controls shall include the following devices and features:
 - 1. Control transformer.
 - 2. Set-Point Adjust: Set points shall be adjustable.
 - 3. Operating Pressure Control: Factory wired and mounted to cycle burner.
 - a. Low-Water Cutoff
- E. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - 1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
 - 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
 - 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- F. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm, low water level alarm.

- b. Control: On/off operation, hot water supply temperature set-point adjustment.
- 2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified on the drawings.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 250, Type 1 enclosure.
 - 2. Wiring shall be numbered and color-coded to match wiring diagram.
 - 3. Install factory wiring outside of an enclosure in a metal raceway.
 - 4. Field power interface shall be to circuit breaker.
 - 5. Provide branch power circuit to each motor and to controls.
 - 6. Provide each motor with overcurrent protection.

2.6 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for wall mounting of boilers, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Vibration Isolation: Elastomeric with a minimum static deflection of 0.25 inch (6.35 mm) >. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Assemble and install all boiler accessories
- E. Install electrical devices furnished with boiler but not specified to be factory mounted.
- F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- I. Boiler Venting:
 - 1. Install flue venting kit and sealed combustion-air intake.
 - 2. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."
- J. Ground equipment according to National Electric Code.
- K. Connect wiring according to National Electric Code.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests:
 - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 - 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
 - 4. Repeat tests until results comply with requirements indicated.
 - 5. Provide analysis equipment required to determine performance.
 - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
 - 7. Notify Architect in advance of test dates.
 - 8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers

END OF SECTION 235216

SECTION 237200 – AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged Air-to-Air Energy Recovery Units.

1.2 SUBMITTALS

- A. Division 01 Section “Submittal Procedures”.

- B. Product Data:

1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, operation and service clearances, and electrical characteristics and connection requirements. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.
2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring. Include recommended wire and fuse sizes or MCA, sequence of operation, connection points, safety and start-up instructions.
6. Submit unit performance including: capacity, nominal and operating performance.
7. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

1.3 SUBMITTALS AT PROJECT CLOSEOUT

- A. Division 01 Section “Closeout Procedures”: Procedures for submittals.

- B. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.4 QUALITY ASSURANCE

- A. Energy Recovery Units: Product of manufacturer regularly engaged in production of components, who issues complete catalog data on product offering. Manufacturer shall have minimum 3 years’ experience.

- B. Energy Recovery Units: Certify air volume, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430. If air handling units are not certified in accordance with ARI 430, Contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the Contractor.

- C. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-91.

1.5 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01 Section "Product Requirements": Transport, handle, store, and protect products.
- B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units shipped not fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Each section shall have lifting lugs to allow for field rigging and final placement of section.
- C. Deliver units to site with fan motors, sheaves, and belts completely assembled and mounted in units.
- D. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- E. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 Section "Product Requirements": Environmental conditions affecting products on site.
- B. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.8 EXTRA MATERIALS

- A. Division 01 Section "Closeout Procedures."
- B. Provide 1 set of filters for each unit, to the Owner in clean, sealed containers.

PART 2 - PRODUCTS

2.1 AIR-TO-AIR HEAT RECOVERY UNITS

- A. Approved Manufacturers:
 1. Xetex – Basis of design.
 2. Venmar
 3. Approved equal.

2.2 AIR-TO-AIR HEAT RECOVERY UNIT SPECIFICATION

A. General:

1. Factory assembled unit, consisting of fan and motor assemblies (supply and exhaust), Air-To-Air Plate Heat Exchanger, necessary dampers, hoods, plenums, filters, drain pans, wiring and controls. Unit shall be stand-alone controlled (with start/stop signal from the building's automatic temperature control system) with control devices provided by unit manufacturer. Unit shall have single point power connection. Provide contact points as required for interface of start/stop signal from the building's automatic temperature control system - coordinate with Division 23 – Instrumentation and Control for HVAC.
2. Motor and Electrical Components: Refer to Division 23 – Common Motor Requirements for HVAC Equipment for motor requirements.

B. Unit Cabinet:

1. The unit base frame shall be constructed from a bolted formed structural channel (5 in. high) with internal structural cross members properly sized to allow rigging and handling of the unit. Major components shall be supported by the base without sagging or pulsating. A minimum of four (4) lifting lugs shall be provided, one at each unit corner.
2. Unit construction shall be of insulated 16 ga galvanized structural frame complete with die cast aluminum corners. Panels shall be double wall construction using 2" (25.4 mm) thick fiberglass R-8 insulation, 1.5 lb/cu.ft ((24 kg/m³) density, 18 Ga. G90 galvanized steel exterior panels and 26 Ga. G90 galvanized steel liner. Single wall construction with coated insulation shall not be acceptable.
3. Provide full size access doors located to allow periodic maintenance and inspections. Doors shall be double wall, insulated construction made of 18 Ga. galvanized steel on both outer and inner liner for maximum rigidity. Provide doors with heavy duty corrosion proof aluminum hinges, compression type handles and resilient gaskets (-30 to 150 F (-34 to 66 C)). Door openings shall be flush with surrounding panels. Removable latches and continuous hinges shall not be acceptable.
4. Floor shall be double wall construction and shall be insulated with 5" (127 mm) fiberglass insulation. Floor top sheet shall be constructed of 18 ga G90 galvanized steel. Sub-floor shall be constructed of 18 ga G90 galvanized steel. Single wall floor construction shall not be acceptable.
5. Drain pans: Recessed drain pans shall be made of formed sections of 18 Ga. G90 galvanized steel or stainless steel. Drain pans shall be sloped at a minimum of 1.5% with a drain pipe connection of 1" ending outdoor thru the structural base channel.
6. Paint: Cabinet shall have epoxy primer and corrosion resistant paint of color as selected by the architect. Submit color chart for selection by architect.

- ### C. Air-To-Plate Heat Exchanger:
- The air to air plate heat exchanger shall be a cross-flow type fabricated with embossed aluminum plate made of pure aluminum designed to maximize efficiency and cleanability while minimizing pressure loss. The heat exchanger shall withstand a temperature of up to 300°F (149 C). The heat exchanger assembly shall be certified as to performance and certified for 0% cross contamination per ASHRAE 84-78 and shall be able to withstand 8 in. wg (1990 Pa) of pressure differential between airstreams. Access to all four sides of the exchanger for cleaning and inspection shall be provided. An access section with a sloped drain pan shall be provided upstream and downstream of the heat exchanger. This shall allow for service, collection of condensate, and cleaning of the plate without allowing any standing water to be contained within the unit cabinet.

D. Fans:

1. Testing Requirements: Fan performance ratings for flow rate, pressure, power, air density, speed of rotation, and efficiency shall be factory tested.
2. Fan Section Construction: Fan and motors shall be mounted inside the casing on integral bases with 1 in. (25.4 mm) deflection spring vibration isolators and supplied with flexible connections. Spring thrust restraints shall be supplied for stable operation and to protect the flexible connections from tearing.
3. Equip units with forward curved, DWDI supply and exhaust fans to provide scheduled air flows against static pressures indicated.
4. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan shaft shall be solid steel, turned, ground, and polished. Fan wheels shall be keyed to the shaft.
5. Shaft Bearings: Bearings shall be heavy-duty grease lubricated self-aligning ball or pillow block type. Bearing shall be selected for a basic rating fatigue life (L-50) in excess of 200,000 Hours at maximum operating speed.
6. Fan Drives: Designed for a 1.4 service factor and factory mounted with final alignment and belt adjustment made after installation. Belt Drive: Motors and fan wheel pulleys shall be adjustable pitch for use with motors up to and including 15 HP.

E. Motors:

1. Fan motors shall be heavy duty, high efficiency, open drip proof NEMA Design B with Class B insulation and 1.15 service factor. Motors shall be operable at field voltage: 480 Volts, 60 Hz, 3 phase.
2. Fan motors shall be mounted and isolated on the same integral base as the fan.
3. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.
4. Motor Sizes: Minimum size as indicated in equipment schedule. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.
5. Temperature Rating: 50 C maximum temperature rise at 40 C ambient for continuous duty at full load (Class A Insulation).
6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design B.
 - a. Bases: Adjustable.
 - b. Bearings: The following features are required:
 - 1) Ball or roller bearing with inner and outer shaft seals.
 - 2) Grease lubricated.
 - 3) Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
 - c. Efficiency: Energy-efficient motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, Test Method B. If efficiency not specified, motors shall have a higher efficiency than “average standard industry motors” in accordance with IEEE Standard 112, Test Method B.

F. Filters:

1. Filters shall comply with NFPA Standard 90A (Class I or II) “Standard for the Installation of Air Conditioning and Ventilating Systems.”
2. Filters shall comply with section.
3. Filter Section: Outside air inlet shall be equipped with galvanized steel racks to provide for slide out removal of filters, with filter media holding frames arranged for flat orientation.
4. Disposable Filters: Provide disposable type air filters, 2 inches (50 mm) thick, 25-30% DSE efficiency, MERV 13 or equal.

- G. Dampers:
1. General: Leakage rate when tested in accordance with AMCA Standard 500 - Test Method for Louvers, Dampers and Shutters, shall not exceed 0.6% of air quantity calculated at 10 inwg. (type OB).
 2. Unit shall be equipped with necessary dampers for outside air intake, exhaust air and defrost system.
 3. Unit shall be equipped with face and bypass damper control for the hot water coil.
 4. Unit dampers shall be motorized. Provide damper actuators as manufactured by BELIMO, model NF or AF, 24 VAC driven voltage. 0-10 VDC modulation shall be available when needed. Actuators provided shall comply with Division 23 Section "Instrumentation and Controls for HVAC."
 5. Damper frame shall be extruded aluminum.
 6. Blades shall be extruded aluminum.
 7. Dampers shall be opposed blades type for modulating dampers and parallel blades for two position dampers.
 8. Damper blade ends shall be sealed with neoprene flexible edge seals c/w bottom and top blade wiper seals.
 9. Frame and blades shall be non isolated.
- H. Hydronic Coils:
1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
 3. Locate water supply at bottom of supply header and return water connection at top.
 4. Provide manual air vents at high points complete with stop valve.
 5. Ensure water coils are drainable and provide drain connection at low points. Provide ball valve with hose end connection inside of building for draining unit's coil.
 6. Unit shall be configured with the hydronic coil located such that piping connections are within the envelope of the unit housing. Units that require heating coil piping to penetrate the roof outside of the unit housing and be encased in an insulated "box" shall not be allowed.
- I. Defrost Strategy: Traversing defrost system (DDC controlled) shall be provided. Independent traversing dampers with actuators. Traversing defrost systems using a single blade moving back and forth in front of the heat exchanger shall not be permitted.
- J. Warranty: Manufacturer shall provide 2 year warranty on parts, and 15 years on the air to air plate heat exchanger excluding labor. Warranties of less duration shall not be acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Division 01 Section "Quality Requirements": Manufacturer's instructions.
- B. Install in accordance with ARI 435.
- C. Bolt sections together with gaskets. Isolate fan section with flexible duct connections; refer to Division 23 Section "Air Duct Accessories."

- D. Install flexible connections specified in Division 23 Section "Air Duct Accessories" between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.
- E. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- F. Provide sheaves and belts required for final air balance (coordinate with Division 23 – Testing, Adjusting, and Balancing for HVAC)
- G. Make connections to coils with unions or flanges.
- H. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
 - 3. Locate water supply at bottom of supply header and return water connection at top.
 - 4. Provide manual air vents at high points complete with stop valve.
 - 5. Ensure water coils are drainable and provide drain connection at low points.
 - 6.
- I. Extend coil drain and vent ports through the unit housing and terminate with ball valves and caps. Provide sealing collars or grommets at penetrations through unit housing to eliminate air leakage.
- J. Support piping near the unit with isolators.
- K. Insulate coil headers located outside air flow as specified for piping. Refer to Division 23 Section "HVAC Piping Insulation."
- L. Foundations:
 - 1. Where floor mounting is indicated, locate equipment on 4" (102 mm) high reinforced concrete pad of adequate size with anchors and base plates as required, on pressure-treated sleepers, or on structural steel frame as detailed. The corners of pads shall be chamfered 1/2" (13 mm). Pad and steel sizes and location shall be coordinated with the approved equipment.
- M. Lights: Provide field-furnished 100-watt-equivalent compact fluorescent lamps in the fan-section light fixtures.

3.2 TESTING

- A. After the entire installation is completed, ready for operation, test the systems. The Owner will provide electric current for the tests. Provide necessary labor, test pump, gauges, meters, other instruments and materials. Perform tests in the presence of the Architect. Dampers and fan speed controllers shall operate smoothly through their entire range. Unit shall operate without objectionable noise.

3.3 CLEANING

- A. The entire system installations including apparatus, motors, inside of ducts, and other components, shall be left in first-class condition including cleaning, oiling and packing.
- B. Provide filters at system start-up. Replace filters after air systems have been adjusted and balanced. Provide the Owner with one additional set of filters for air handling units.

3.4 ADJUSTMENTS

- A. After completion of the installation work called for in this Specification, furnish necessary Mechanics or Engineers for the adjustment and operation of the plant, to the end that the plant may be perfectly adjusted and turned over to the Owner in perfect working order. Further instruct the Owner's authorized representative in the care and operation of the installation, providing required framed instruction charts, directions, and other relevant information and documentation.

3.5 NAMEPLATES, TAGS AND CHARTS

- A. Provide engraved plastic nameplates to identify equipment, controls, and other components. Refer to Division 23 Section "Duct Insulation." Provide nameplates secured to each air handling unit indicating quantity and size of filters required.

3.6 ALTERATIONS

- A. Execute alterations, additions, removals, relocations or new work, and other work, as indicated or required to provide a complete installation in accordance with the intent of the Drawings and Specifications.
- B. Any existing work disturbed or damaged by the alterations or new work shall be repaired or replaced to the Architect's satisfaction and at no additional cost to the Owner.
- C. Existing ductwork, piping, and other systems, indicated to be removed, shall be removed from the site. Cap off existing services remaining. The Owner retains the right to ownership of heating and ventilating equipment scheduled to be removed; store such equipment where requested by the Owner. Material not retained by the Owner shall be removed from the site.

3.7 CONTINUITY OF SERVICE

- A. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted service for the building or any of its locations. Any unavoidable conditions requiring reduced building capacity shall be arranged for by programming with the Owner's duly authorized representative at the building subject to the Architect's approval. If necessary, temporary work shall be installed to provide for the condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal service shall be performed during an overtime period to be scheduled with the Owner. Costs for overtime work shall be included in the bid.

END OF SECTION 237200

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SECTION 238126 - VRV AC SYSTEM

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Variable capacity, variable refrigerant flow heat pump and air conditioning split systems.
- B. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- C. All wiring shall be in accordance with the National Electric Code (NEC).
- D. The system will bear the Energy Star label.
- E. 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.

1.2 DELIVERY, STORAGE AND HANDLING

- A. Units shall be stored and handled according to the manufacturer's recommendations.

PART 2 - WARRANTY

2.1 WARRANTY

- A. The units shall have a manufacturer's warranty for a period of 10 years parts only for compressor(s) and 2 years parts only for all other parts. The warranty period shall begin once all of the equipment has been installed, started up by a Factory Authorized Representative, commissioned and placed into service. Equipment shall not be placed into service until startup is performed by a Factory Authorized Representative.

PART 3 - PRODUCTS

3.1 ACCEPTABLE MANUFACTURERS

- A. The following Manufacturers are acceptable:
 - 1. Daikin.
 - 2. Mitsubishi.
 - 3. Fujitsu.
 - 4. York, a division of Johnson Controls.
 - 5. Approved equal.

3.2 OUTDOOR UNITS

- A. General: The outdoor unit is designed specifically for use with VRV series components.
1. The outdoor 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 a variable speed scroll compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receivers and accumulators.
 2. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.
 3. The outdoor unit can be wired and piped with outdoor unit access from left, right, rear or bottom.
 4. The connection ratio of indoor units to outdoor unit will be 50% to 130%.
 5. The sound pressure dB(A) at rated conditions shall be a value of 58 decibels at 3 feet from the front of the unit. The outdoor unit shall be capable of operating at further reduced noise during night time.
 6. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.
 7. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
 8. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature. Oil recovery cycle shall be automatic occurring 1 hour after start of operation and then every 6 hours of operation.
- B. Unit Cabinet:
1. The outdoor unit shall be completely weather proof and corrosion resistant. The units shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- C. Fan:
1. The condensing unit shall consist of one propeller type, direct-drive fan 750 W motors that have multiple speed operation via a DC inverter.
 2. The condensing unit fan motor shall have multiple speed operation of the DC inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG with available by field setting switch to a maximum 0.24 in. WG pressure.
 3. The fan shall be a vertical discharge configuration.
 4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
 5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
- D. Condenser Coil:
1. The condenser coil shall be manufactured 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 exchanger, rifled bore tube design to ensure highly efficient performance.
 3. The coils shall be complete with corrosion treatment of an acrylic resin type. The thickness of the coating must be between 2.0 to 3.0 microns.

E. Compressor:

1. The scroll compressor shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC, hermetically sealed scroll type with a maximum speed of 6,480 rpm.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be 14% to 100%, with 29 individual capacity steps. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
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 oil balancing circuit.
7. The compressor shall be mounted to avoid the transmission of vibration.

F. Electrical:

1. The power supply to the outdoor unit shall be 460 volts, 3 phase as scheduled, 60 hertz.
2. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.
4. The control wiring lengths are:

3.3 Indoor Unit:

1. The indoor units 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, 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 indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift.
5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

B. 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 connection to LonWorks networks or interfacing with connection to BMS system. Consult with Manufacturer prior to applying controls.

C. Accessories Available:

1. Remote “in-room” sensor kit.
 - a. Wall mounted, hard wired remote sensor kit for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit.).

END OF SECTION 238126

SECTION 238200 – CONVECTION HEATING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cabinet Unit Heaters.
- B. Unit Heaters.

1.2 RELATED SECTIONS

- A. Division 23 Section “Hydronic Piping.”
- B. Division 23 Section “Hydronic Specialties.”
- C. Division 23 Section “Instrumentation and Control for HVAC.”
- D. Division 26 “Electrical”

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

- A. Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 3. Indicate mechanical and electrical service locations and requirements.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Division 01 Section “Closeout Procedures”: Procedures for submittals.
- B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owners name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating

instructions, installation instructions, maintenance and repair data, and parts listings. Submit under provisions of Division 01.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

- A. Manufacturers:
 - 1. Sterling Hydronics.
 - 2. Daikin Applied (formerly McQuay).
 - 3. Price Industries.
 - 4. Trane.
- B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi (1380 kPa) and 220 degrees F (104 degrees C).
- C. Cabinet: 0.0598 inch (1.5 mm) steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet and inlet grilles.
- D. Finish: Factory applied baked enamel of color as selected by the Architect on visible surfaces of enclosure or cabinet.
- E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- F. Motor: Tap wound multiple speed permanent split capacitor or shaded pole with sleeve bearings, resiliently mounted.
- G. Control: Multiple speed switch, factory wired, located in cabinet.
- H. Filter: Easily removed 1 inch (25 mm) thick glass fiber throw-away type, located to filter air before coil.
- I. Configuration: Wall mounted, inverted discharge.

2.2 UNIT HEATERS

- A. Manufacturers:
 - 1. Sterling Hydronics.

2. Daikin Applied (formerly McQuay).
 3. Modine.
 4. Reznor.
 5. Trane.
- B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
 - C. Casing: 0.0478 inch (1.2 mm) steel with threaded pipe connections for hanger rods.
 - D. Finish: Factory applied baked enamel.
 - E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
 - F. Air Outlet: Adjustable pattern diffuser on projection models and 4-way double-deflection louvers on horizontal throw models.
 - G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Division 23.
 - H. Control: Local Disconnect Switch.
 - I. Capacity: As scheduled, based on 65 degrees F (18 degrees C) entering air temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage.
- C. Protection: Provide finished cabinet units with protective covers during balance of construction.
- D. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- E. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.
- F. Hydronic Units: Provide with shut-off valve on supply and lockshield balancing valve on return piping. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing. For unit heaters, provide float operated automatic air vents with stop valve.

3.2 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION 238200

SECTION 238316 - RADIANT-HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes radiant-heating piping, consisting of pipes, fittings, and piping specialties.
- B. Distribution manifolds and compatible fittings.
- C. Fasteners approved by manufacturer.
- D. Mixing assemblies.
- E. Controls.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.
- B. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.
- C. Calculations Reports; Show output of the heating/cooling system to include any excess or shortages of heating or cooling, heating/cooling entering the space, flow rates, head loss, back losses of heating/cooling, floor covering resistance, and floor surface temperatures.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Technical Data Sheets.
- C. Product Instructions.
- D. Design Calculation reports.

1.4 WARRANTY

- A. Manufacturer warranty shall include the following:
 - 1. In the event that manufacturer determines that the failure or leak and any resulting damages were the result of a manufacturing defect in the products covered by the warranty and occurred during the first ten years of the time period covered by the warranty, the manufacturer will reimburse the property owner for reasonable repair or

replacement charges resulting from the failure or leak and, additionally will reimburse damages to personal property resulting from the failure or leak.

2. Radiant heat pipe manufacturer shall warranty the tubing under normal conditions of use and properly maintained, will be free from failure caused by manufacturing defect for a period of thirty (30) years from date of installation, when properly installed by contractors trained by manufacturer.
3. PEX Press fittings, when installed with ViegaPEX Barrier and FostaPEX tubing, will be free from failure caused by manufacturing defect for a period of thirty (30) years from date of installation. This also includes protected PEX Press fitting in a slab.
4. Manifolds and panels used in the system will be free from manufacturing defect for a period of five (5) years.
5. Controls, mixing stations, or electrical components sold by manufacturer shall be free from manufacturing defect for a period of two (2) years from date of installation.

PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

A. Manufacturer:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC;
2. Uponor
3. Watts Radiant
4. Approved equal.

B. Pipe Material:

1. PEX tubing and fittings shall maintain a quality control program in accordance with ISO 9001 or NSF International in the manufacturing plant to assure that the tubing and fittings are continually being produced to the required standard.
2. Tubing shall be silane cross-linked high density polyethylene as per ASTM F876/F877 and CSA B137.5.
3. Tubing includes four layers.
 - a. First layer: Cross-linked, high density polyethylene.
 - b. Second layer: Adhesive.
 - c. Third layer: Ethylene vinyl alcohol layer (EVOH oxygen barrier).
 - d. Fourth layer: Polyethylene to protect the EVOH layer from damage.
4. Certified to NSF 14 and 61.
5. Tubing will have 6 month UV protection.

C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.

D. Bronze Fittings: PEX Press Fittings manufactured from UNS C83600 copper alloy, meeting the requirements of ASTM F 877 tested as a system with ViegaPEX Barrier tubing.

1. PEX Press Sleeve: Manufactured out of a 304 grade or better stainless steel, and have one view hole (loose sleeve) or three view holes (attached sleeve) to ensure proper PEX tubing insertion.
2. Attached sleeve fitting will incorporate a tool locator ring that shall be in place while making a proper press connection.
3. PEX press connection shall be made with a Viega supplied ratcheting PEX Press hand tool or PEX Press power tool.

- E. Polymer Fittings: PEX Press Fittings manufactured from Radel-R® polymer, meeting the requirements of ASTM F 877 tested as a system with ViegaPEX Barrier tubing.
1. PEX Press sleeve: manufactured out of a 304 grade or better stainless steel and have three view holes (attached sleeve) to ensure proper PEX tubing insertion.
 2. Fitting will include the Smart Connect feature providing quick easy identification of unpressed connections during the pressure testing process.
 3. Unpressed connections are located by pressurizing the system to 0.5 PSI to 100 PSI (3.4 kPa to 689kPa).
 4. Attached sleeve fitting will incorporate a tool locator ring that shall be in place while making a proper press connection.
 5. PEX Press connection shall be made with a Viega supplied ratcheting PEX Press hand tool or PEX Press power tool.
- F. Pressure/Temperature Rating: ViegaPEX Barrier High-Density Cross-linked polyethylene tubing shall meet the standard grade hydrostatic pressure ratings from the Plastic Pipe Institute in accordance with TR-4/03. The following three ratings are required:
1. 200 deg F (93 deg C) at 80 psi (551 kPa).
 2. 180 deg F (82 deg C) at 100 psi (689 kPa).
 3. 73.4 deg F (23 deg C) at 160 psi (1102 kPa).
- G. Stainless Manifold with Balancing Valves and Flow Meters: Minimum NPS 1 1/4 (DN 32).
1. Manifolds shall be made of 304 Stainless Steel with nickel-plate valve necks on select models.
 2. Flow meters, balancing valves, and shut off valves are integrated on manifold.
 3. Air bleeders and two purge valves are to be integrated on manifold.
 4. Manifolds have 1 in (25 mm) NPT removable end caps and 1 1/4 in (32 mm) Union connections.
 5. Galvanized steel bracket supplied by Viega,
 6. Select manifold cabinet based on manifolds, accessories and fittings added.
 7. Accept optional powerheads for individual zone control.
 8. Manifold is suitable to receive all SVC connections.
 9. Flow Meters for Stainless Manifolds:
 - a. Visual Flow Indicator: Visible indication in a clear plastic cap at top of valve.
 - b. Body Brass: Nickel plated.
 - c. Internal Parts: Plastic, EPDM.
 - d. Inlet Connection: NPS 1/2 (DN 15), 1/2 inch (12.7 mm) with o-ring.
 - e. Measure range: 0 - 2 gpm.
 - f. Handle Style: Rotating ring with lockable cap, no memory stop to retain set position if used for shut off.
 - g. CWP Rating: 100 psi (69 kPa).
 10. Thermometers:
 - a. Mount on connection.
 - b. Case: Stainless steel, 2 inch (50 mm) diameter.
 - c. Element: Bimetal coil element.
 - d. Movement: Mechanical, connecting element and pointer.
 - e. Dial: White aluminum, black lettering.
 - f. Pointer: Aluminum, black.
 - g. Window: Instrument glass, NS 33 polycarbonate.
 - h. Connector: Rigid, back type.
 - i. Accuracy: Plus or minus 2 percent of range.
 11. Maximum Operating Pressure: 100 psi (69 kPa).

12. Maximum Operating Temperature: 180 deg F (82 deg C).

H. Powerheads for Stainless Manifolds (2-wire).

1. Voltage: 24 VAC
2. Maximum Inrush Current: 250 mA for 2 minutes maximum.
3. Operating Current: 75 mA.
4. Closing/Opening Time: Approximately 3 minutes.
5. Stroke: 0.16 inch (4 mm).
6. Actuating Force: 21 lbs (93 N).
7. Weight: 5.5 oz (0.16 kg).
8. Fluid Temperature: 32 deg F (0 deg C) to 212 deg F (100 deg C).
9. Visual Function Indicator.
10. 360 deg Installation Position.
11. Snap-on Installation.

2.2 PIPING SPECIALTIES

A. Foam Mounting Staples:

1. Plastic staple with barbed ends. 2-1/2" x 1" crown
2. Use Viega approved staple gun to install
3. See installation instructions on spacing of fasteners.

B. Mixing devices: specified in Section 230523 "General Duty Valves for HVAC" and Section 232123 "Hydronic Pumps".

C. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC;

2.3 CONTROLS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC;

B. Wall-Mounted Thermostat:

1. Minimum temperature range from 41 to 99 deg F (5 to 27 deg C).
2. Control: Microprocessor.
3. Accuracy: 0.2 deg F (- 18 deg C).
4. Optional Floor Sensor: NTC thermistor (10K ohms), 10 feet (305 mm) cable.
5. Manually operated with on-off switch.
6. Day and manual night setback or external clock program.
7. Operates normally opened or normally closed valves.
8. Operate pumps or open zone control valves if room temperature falls below the thermostat setting, and stop pumps or close zone control valves when room temperature rises above the thermostat setting.

C. Basic Heating Control-Outdoor Temperature Reset Control:

1. Control: Microprocessor PID Control.
2. Approvals: CSA C US< meets ICES & FCC regulations for EMI/RFI.
3. Power Supply: 120 VAC +/- 10 percent 50/60 Hz 1300 VA.
4. Floating Output: 24 VAC 0.34 A 8 V.
5. Relays: 240 VAC 10 A 1/3 hp, pilot duty.
6. Sensors: NTC thermistor.

7. Remote bulb unit with adjustable temperature range from 35 to 100 deg F.
8. Operate based on outdoor air temperature. Control resets supply-water temperature inversely with outdoor-air temperature as follows:
 - a. Low outdoor-air temperature, -20 to deg F with high supply-water temperature 180 deg F.
 - b. High outdoor-air temperature, 50 deg F with low supply-water temperature 70 deg F.
9. Ambient Conditions: Indoor use only, 32 to 102 deg F (0 to 39 deg C), <90 percent RH non-condensing.

D. Zone Valves

E. Voltage – 24V

1. Max inrush current – 300mA for 2 min
2. Operating power – 1w
3. Closing/opening time – approx 3 min
4. Max pressure differential – 50 psi
5. Cv rating of ¾” valve – 4.0
6. Cv rating of 1” valve – 8.5
7. Fluid temperature – 32-212°F
8. Stem travel – 4mm
9. Actuating force – 21 lbs
10. Body material – low zinc bronze, alloy C84400

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to manufacturer's most current installation instructions.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings or coordination drawings.
- C. Install ViegaPEX Barrier at least 4 inches (102 mm) from edge of slabs, walls or other permanent objects.
- D. Install ViegaPEX Barrier continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels. If coupling is required, use Viega PEX Press fitting and wrap in Viega's Coupling Repair Tape.
- E. Avoid crossing tubing in slab unless minimum concrete thickness is met.
- F. Square off ViegaPEX Barrier or FostaPEX with approved PEX Cutters.
- G. Connect ViegaPEX Barrier or FostaPEX to manifold using approved Viega Manifold Adapter.
- H. Use bend supports for pipe entering and exiting the slab.

- I. Do not bend pipe in radii smaller than manufacturer's minimum bend radius.
- J. Manifolds should be installed with brackets supplied by Viega LLC.
- K. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Division 08 Section "Access Doors and Frames".
- L. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Division 07 Section "Penetration Firestopping".
- M. Piping in Interior Reinforced-Concrete Floors:
 - 1. Secure piping by attaching pipes to reinforcement or insulation using approved fasteners from manufacture.
 - 2. Space fasteners a maximum of 24 inches (610 mm) and at center of turns and bends.
 - 3. Maintain 2-inch (51-mm) minimum cover.
 - 4. Install vapor barrier and insulation as per the radiant design. Ensure compression rating is suitable for structural engineer.
 - 5. If pipe is being secured to insulation space fasteners a maximum of 24 inches (610 mm) and at center of turns and bends
 - 6. If RapidGrid™ is being used fastening is integrated into insulation and not additional fasteners are required.
 - 7. Install a sleeve of 3/8-inch (9.5-mm) thick, foam-type insulation PVC or PE pipe around tubing and extending for a minimum of 6 inches (152 mm) on each side of slab expansion joints to protect the tubing passing through expansion joints. Anchor sleeve to slab form at expansion joints to provide maximum clearance for saw cut.
 - 8. If tube passes metal expansion joints pass tubing under the joint.
 - 9. Maintain pressure test of a minimum 100-psig (689-kPa) or 1.5 times system working pressure.
 - 10. After initial pressurization, ensure pressure has not dropped after 20 minutes. Fluctuations may occur due to temperature fluctuations and tubing expansion. If a drop has occurred add pressure to the system Carry out testing for a minimum of 1 hour.
 - 11. Maintain pressure in piping during concrete and floor covering installation and continue for 24 hours after placement.
- N. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
- O. After system balancing has been completed, mark balancing valves to permanently indicate final position per design.
- P. Perform the following adjustments before operating the system:
 - 1. Open valves to fully open position.
 - 2. Check operation of automatic valves.
 - 3. Set temperature controls so all zones call for full flow.
 - 4. Purge air from piping.
- Q. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:
 - 1. Start warm up after concrete has reached its final set (curing complete).
 - 2. Set supply water temperature to 77 deg F (25 deg C) for the first three days.

3. Increase supply water temperature to the set point in gradual increments for the next 4 days. Maximum of a 50 deg F (10 deg C) increase in a period of 24 hour).
4. For freeze protection, operate at a minimum of 60 deg F (16 deg C) supply-water temperature or provide adequate antifreeze protection.

3.2 FIELD QUALITY CONTROL

- A. Prepare radiant-heating piping for testing as follows:
 1. Open all isolation valves and close bypass valves.
 2. Open and verify operation of zone control valves.
 3. Flush with clean water and clean strainers.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig (690 kPa). Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Radiant-heating piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Protect hydronic piping system from damage during construction.

END OF SECTION 238316

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SECTION 260010 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Electrical Requirements specifically applicable to all Division 26 Sections.
- B. Intent is to provide and install complete electrical systems, as required to accommodate the new building.
- C. Access Panels: Where required by NFPA 70 (N.E.C.)
- D. All cable bundles shall be limited to a maximum of 12 cables, individual bundles of cables shall be separated by at least two (2) inches in all directions.
- E. Seismic Requirements

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to this section. Examine all contract documents for requirements affecting the work.

1.3 DEFINITIONS

- A. As used in this section, "provide" shall mean, "furnish and install". "furnish" shall mean "to purchase and deliver to the project site complete with every necessary appurtenance and support", and "install" shall mean "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project".

1.4 WORK BY OWNER

- A. Telephone PBX System
 - 1. Administration & classroom private handset. Communications to outside lines with individual restrictions.
- B. Network equipment and software such as servers, Network Switches, HUBs, transceivers to activate the LAN.
- C. Interactive presentation devices such as TV's, Interactive White Boards (IWB) and Video Projectors.
- D. Work Stations, Laptops, Tablets

1.5 OWNER FURNISHED PRODUCTS

- A. Products Furnished to The Site And Paid For By Owner:
 - 1. Kitchen equipment.

2. Microwaves.

- B. Work Associated with Owner Furnished Products and Provided under Division 26:
1. All interconnecting wiring and all final connections as required for complete operating systems. Coordinate with the Owner for specific requirements.

1.6 SUBSTITUTIONS

- A. Refer to Division 01 for Substitutions and Product Options.

1.7 ALLOWANCES

- A. Cash Allowance: Refer to Division 01 Section "Allowances".

1.8 ALTERNATES

- A. Specified under Division 01 Section "Alternates".
- B. Coordinate related work and modify surrounding work as required.

1.9 REFERENCES

- A. NEMA Standards.
- B. NECA "Standard of Installation."
- C. NFPA 70 (N.E.C.) latest edition.
- D. NFPA 101 Life Safety Code.
- E. U.L. Standards.
- F. ANSI Standards.
- G. Maine Uniform Building and Energy Codes (MUBEC) which include provisions of:
1. (IBC) International Building Code.
 2. (IEBC) International Existing Building Code.
 3. (IRC) International Residential Code.
 4. (IECC) International Energy Conservation Code.
 5. ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality.
 6. ASHRAE 62.2 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.
 7. ASHRAE 90.1 Energy Standard for Buildings except Low-Rise Residential Buildings.
 8. ASTM E1465-06 Radon Standard for new residential construction - (Maine Model Standard).

1.10 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".

- B. Include products specified in Division 26 individual sections.
- C. Submit Shop Drawings and product data grouped by individual Sections to include complete submittals of related systems, products, and accessories. Label each with Section number and title. Partial Section submittals will not be reviewed.
- D. Include access panels.
- E. Include fire-stop seals and fillers.

1.11 RECORD DRAWINGS

- A. Submit under provisions of Division 01 Sections “Operation and Maintenance Data” and “Project Record Documents”.
- B. Keep a marked set of Drawings at the site as a record set indicating all revisions in the work as the work progresses. At the completion of the work, mark the Drawings "As-Built Drawings" with the Contractor's name and date, and deliver to the Architect.

1.12 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of the latest edition of ANSI/NFPA 70 National Electrical Code (N.E.C.).
- B. Conform to requirements of all local, State and Federal laws and regulations, plus local electric utility company's rules, and the Fire Underwriters' requirements.
- C. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- D. Secure and pay for all permits and certificates as required by local, State and Federal laws.
- E. Request inspections from authority having jurisdiction.
- F. Run separate circuits for lighting and receptacle outlets as indicated.
 - 1. Circuits shall be balanced and loads and capacities shall be in accordance with requirements of local electric light company and National Board of Fire Underwriters.
 - 2. Do not share neutral on branch circuits.
- G. The entire electrical system shall be permanently and effectively grounded in accordance with Code requirements.
- H. The Drawings indicate only diagrammatically the extent, layout and the general location and arrangement of equipment, conduit and wiring. Become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment will be properly located and readily accessible.
 - 1. Note that drawings do not show all junction boxes and fixture whips for lighting fixtures recessed in accessible ceilings. Although not specifically shown on the drawings, these fixtures shall be wired from junction boxes and maximum 6'-0" unsupported whips. Provide number of junction boxes as required allowing for the maximum 6'-0" whips. Wiring from fixture to fixture is not allowed. See Division 26 Section “Luminaires”.

2. Lighting and Devices shown with same panel and circuit designation with no home run symbol may share same home runs to panelboards provided that the furthest device on the circuit does not exceed 2-1/2% voltage drop.
3. Where home run symbols are shown, use separate run to panelboard for each symbol, and do not share home run with other devices having same panel and circuit designation.

1.13 PROJECT/SITE CONDITIONS

- A. Coordinate with all other trades to ensure proper access and space requirements.
- B. Where project conditions occur necessitating departures from the drawings, submit for approval the details of and reasons for departures prior to implementing any change.
- C. Alterations
 1. Visit the site and become familiar with the existing conditions, and the requirements of the Plans and Specifications. No claim will be recognized for extra compensation due to failure of becoming familiar with the conditions and extent of the proposed work.
 2. Execute all work as indicated or required to provide a complete installation in accordance with the intent of the Drawings and Specifications.

1.14 SEQUENCING AND SCHEDULING

- A. Construct Work in sequence under provisions of Division 01 Section "Summary".
- B. Schedule and coordinate all work with Division 31, 32, 33.

1.15 TEMPORARY LIGHT AND POWER

- A. "Temporary Light and Power" specified under Division 01 Section "Temporary Facilities and Controls".

1.16 COORDINATION DRAWINGS

- A. As a requirement of this specification, the Contractor shall participate in the development of a set of common coordination drawings for the project.
- B. The mechanical HVAC contractor shall be responsible to manage the coordination drawing effort and submit the drawings as shop drawings for review and comment. The HVAC contractor shall develop the base floor plans and building sections and place his mechanical equipment ductwork and piping on them. He shall then coordinate and manage each Trade's effort while they place their information on the same drawings.
- C. Each trade: Plumbing, fire protection and electrical shall work with the Mechanical HVAC contractor to help produce the coordination drawings. Each trade shall be responsible to coordinate their own equipment, piping, conduit, tray and other associated materials with the other trades and place this information on the drawings.
- D. The coordination drawings may be CAD or hand drafted as selected by the mechanical HVAC contractor. Floor plans shall be prepared at a minimum scale of 1/4" = 1'. Sections through an

entire wing shall be prepared at a minimum scale of 1/4" = 1'. Detail sections across corridors or other small areas shall be prepared at a minimum scale of 1" = 1'.

- E. Coordination drawings shall be prepared for all areas of the facility. The drawing detail shall be sufficient to insure coordination between the trades and also with the building structure. As a minimum the following shall be shown in plan and section:
1. Building structure.
 2. All major equipment.
 3. All ceiling-mounted equipment in ceiling grid, i.e: lighting fixtures, HVAC diffusers, sprinklers, etc.
 4. Ceilings in elevation
 5. All duct work
 6. All major duct, pipe, conduit and tray runs
 7. All work in corridors
 8. Single pipe and conduits run outside of corridor areas when greater than 1 2" in diameter.
 9. As a minimum, indicate elevation of sprinkler piping in all areas.
- F. Mechanical HVAC, plumbing, fire protection and electrical construction shall not commence until coordination drawings have been reviewed and approved. The Contractor shall bring any coordination issues to the attention of the Architect. Review of the coordination drawings by the Architect does not relieve the Contractor of his/her responsibility to provide a properly coordinated construction project.

1.17 SEISMIC DESIGN

- A. This project requires special provisions for the support and restraint of equipment components of the Life-Safety system. The building has a Seismic Design Category = C and an Occupancy Category = III (3). Confirm Seismic design criteria with Structural Drawings. Components of this system shall continue to function after an earthquake. These provisions shall be incorporated in accordance with the following:
1. The requirements of this Section are complementary and additional to requirements listed elsewhere for the fastening and support equipment and components.
 2. Life-safety systems shall be adequately supported and restrained to resist seismic forces in accordance with the 2009 International Building Code and associated supplements.
 3. Seismic Restraints for Equipment:
 - a. Engage the services of a professional engineer (hereinafter known as the Engineering Specialist) with experience in the field of equipment support and seismic restraints. The Engineering Specialist shall select and coordinate the restraints and supports based on the final coordinated drawings showing exact locations of equipment and shall coordinate with the project Structural Engineer to ascertain that the connections to the structure will resist the horizontal forces to which they might be subjected. Submit details and calculations from the Engineering Specialist as required to demonstrate compliance. Equipment that shall be considered in the Engineering Specialist's seismic design shall include, but not be limited to all components of the Electrical Life-safety systems:
 - 1) Emergency Generator support
 - 2) Automatic transfer switches.
 - 3) Feeder and branch circuits
 - 4) Transformers and panelboards.

- 5) Lighting fixtures served from the life-safety automatic transfer switch (ATS-LS) and auditorium emergency lighting transfer switch (ELTS).
 - 6) Fire Alarm Panels and distribution
 - 7) Other components as may be require to assure proper operation of the building electrical life-safety systems.
- 4. Refer to Structural Drawings for exposure group and performance category.
 - 5. Provide floor-mounted equipment with approved seismic control devices as required to prevent overturning or movement. Seismic devices shall be capable of keeping equipment captive under seismic loads.
 - 6. Provide suspended equipment with approved seismic control devices as required to maintain the equipment in a captive attitude under seismic loads.

PART 2 - PRODUCTS

2.1 PAINTING

- A. Refer to Division 09 Section "Painting".

2.2 ACCESS PANELS

- A. Access panels required for items furnished under Division 26 shall be provided under this Division and installed under Divisions 08 and 09.
- B. Standard panels: 12" x 16" except as indicated. Doors: flush type 14-gauge steel, hinged to 16-gauge frame. Latch: Flush face screwdriver operated. All factory primed and painted to match in the field.
 - 1. Same U.L. fire rating as wall, floor, or ceiling in which they are installed.
 - 2. Equal To: Inryco/Milcor style "M" and Miami-Carey "HM".

2.3 VIBRATION ISOLATION MOUNT TYPES

- A. Type DNP (Double Neoprene Pad)
 - 1. Neoprene pad isolators shall be formed by two layers of 1/4" to 5/16" thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
 - 2. Type DNP isolators shall be formed from one of the following products or approved equal:

Type NR.....	Amber/Booth
Type Korpad	Korfund Dynamics
Type WSW.....	Mason Industries
Type NPS.....	Kinetics Noise Control
Series Shear Flex	Vibration Mountings & Control
- B. Type HN (Hanger Neoprene)
 - 1. Vibration isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting

the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing.

2. Type HN isolators shall be one of the following products or approved equal:
 - Type BRD-AAmber/Booth
 - Type H Korfund Dynamics
 - Type HD Mason Industries
 - Type RH or FH Kinetics Noise Control
 - Type RHD or RFD..... Vibration Mountings & Control

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION

- A. Execute all work in a neat manner acceptable to the Local and State Electrical Inspector and Engineer. Follow manufacturer's installation recommendations.
- B. All electrical components and their attachments shall be properly supported and where required shall be designed for seismic forces.
- C. Lighting fixtures shall be supported from structural steel. Provide unistrut channels or equal to span between top cord of joists. See Division 26 "Luminaires".
- D. Perform all electrical work by licensed electricians well skilled in the trade and supervised by a Master Electrician.
- E. Replace or repair to new condition, defective equipment and equipment damaged during installation or testing.
- F. Isolation Mounts: All mounts shall be aligned squarely above or below mounting points for the supported equipment.
- G. Position isolated electrical equipment so that it is free standing and does not come in rigid contact with the building structure or other systems.

3.2 TESTING AND ADJUSTING

- A. The entire installation shall be free from short circuits and improper grounds. Test in the presence of the Architects or their representatives.
- B. Test feeders with the feeders disconnected from the branch circuit panels.
- C. Test each individual branch circuit at the panel. In testing for insulation resistance to ground, the power equipment shall be connected for proper operation. In no case shall the insulation resistance be less than that required by the National Electrical Code and the manufacturer's recommendations. Correct failure in a manner satisfactory to the Architect and Engineers.
- D. Completely test and adjust each system specified under Division 26 for proper operation.

3.3 SLEEVES, INSERTS AND OPENINGS

A. Sleeves:

1. Furnish and install all sleeves required for the work.
2. Sleeves through exterior building walls or through concrete construction shall be rigid galvanized steel.
3. Sleeves shall be sized to provide a total of not less than 1/2-inch clearance around conduit.
4. Sleeves for setting into walls shall be flush with finished construction. Sleeves for setting into floor shall be embedded in concrete slab and extend approximately 2 inches above finished floors.
5. All sleeved openings within building shall be sealed airtight using fire barrier caulking with a UL classification for use as a fire penetration seal for walls and floors with up to a 3-hour fire rating expanded.
6. Sleeves shall be provided in all locations where cables and conduits penetrate walls and floors.
7. Selection of firestopping materials and installation shall be in accordance with specifications Division 07 Section "Penetration Firestopping" for Firestopping".

B. Manufactured Fire Stopping Plug.

1. Provide at fire and smoke rated walls and as where directed on plan.
 - a. Provide one on corridor side of smoke rated walls.
 - b. Fire rating: Not less than the fire-rating on the wall construction being penetrated.
2. Hilti: CFS-PL Firestop Plug or approved equal.

END OF SECTION 260010

SECTION 260111 – CONDUIT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal Conduit.
- B. Flexible Metal Conduit.
- C. Electrical Metallic Tubing (EMT).
- D. Non-Metallic Conduit.
- E. Fittings and Conduit Bodies.
- F. Innerduct - Non-Metallic Corrugated Flexible Raceway.

1.2 RELATED SECTIONS

- A. Division 01 Section “Submittal Procedures”.
- B. Division 07 Section “Penetration Firestopping.”
- C. Section 260010 “Basic Electrical Requirements”.

1.3 REFERENCES

- A. NECA "Standard of Installation."
- B. NEMA Standards.
- C. NFPA 70 N.E.C. latest edition.
- D. U.L. Standards.

1.4 DESIGN REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70 (N.E.C.)
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- C. Conduit Size: ANSI/NFPA 70 (N.E.C.) for conductors indicated. Increase size as required to include bonding conductors specified.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".
- B. Include PVC-coated rigid steel conduit
- C. Include nonmetallic conduit (PVC) with associated fittings and describe intended use.
- D. Include expansion fittings for all conduit types used on the project.
- E. Include fire-stop seals and fillers.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data" and "Project Record Documents".
- B. Accurately record actual routing of all underground and other conduits 2" and larger.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Division 01.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to meet project conditions.
- D. Where conduit routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

- A. Except as otherwise specifically noted, all wiring throughout the building, including each of the systems specified, and shall be enclosed in minimum size 3/4 inch conduit.

- B. Underground Installations:
1. More than Five Feet from Foundation Wall: Use rigid galvanized steel conduit, intermediate metal conduit, plastic coated steel conduit, thickwall nonmetallic conduit PVC-80, thinwall nonmetallic conduit PVC-40 encased in concrete where indicated.
 2. Within two feet of pole base: Use rigid galvanized steel conduit.
 3. Within five feet from foundation wall: Use rigid galvanized steel conduit, intermediate metal conduit, plastic coated steel conduit, thickwall nonmetallic conduit PVC-80, thinwall nonmetallic conduit PVC-40.
 4. In or Under Slab on Grade:
 - a. Use rigid galvanized steel conduit, intermediate metal conduit, plastic coated steel conduit, thickwall nonmetallic conduit PVC-80 and thinwall nonmetallic conduit PVC-40.
 - b. Rise through slab in rigid galvanized steel conduit.
 - c. Conduit larger than 3/4" shall run below slab.
 5. Minimum Size: 3/4 inch.
 6. Under paved areas: rigid galvanized steel conduit or concrete encased PVC-40.
 7. Metallic conduits buried in soil: Coated with Bitumastic #50.
 8. Primary electrical service conduits from riser pole to pad mounted transformer: concrete encased PVC-40.
 9. Communications (telephone, data, catv) service entrance conduits from riser pole to building: concrete encased PVC-40, concrete encased where indicated.
- C. Outdoor Locations, Above Grade: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit.
- D. In Slab Above Grade:
1. Use rigid galvanized steel conduit, intermediate metal conduit, electrical metallic tubing with water tight connectors.
 2. Maximum Size Conduit in Slab: 3/4 inch.
 3. Rise through slab in rigid galvanized steel conduit.
- E. Interior Wet and Damp Locations: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit.
- F. Dry Locations:
1. Concealed: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit, electrical metallic tubing.
 2. Concealed/ Accessible: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit, electrical metallic tubing.
 3. Exposed: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit, electrical metallic tubing.
 - a. Exposed conduit: Not allowed in finished areas except as specifically noted.
- G. Panel Feeders: Use electrical metallic tubing and PVC-40 in accordance with locations herein specified.
- H. Couplings and connectors for electrical metallic tubing up to 2" shall be steel set screw or compression type. Set-screw connection shall be used for all tubing sizes with a minimum of four set-screws for coupling and two set-screws for connectors and fittings for sizes 1-1/4" and larger.

- I. Couplings and connectors for rigid and intermediate metal conduit shall be threaded.
- J. Termination for all conduit and tubing shall have insulated bushings or insulated throat connectors in accordance with code requirements.
- K. Permanent Connection to Motors: Dry locations, use flexible metal conduit. Damp or wet locations, use flexible liquidtight Type UA conduit with approved liquidtight fittings. Maximum length two feet (2').

PART 3 - EXECUTION

3.1 INSTALLATION

- A. In general, all raceways shall be concealed above ceilings and within finished walls - securely supported in accordance with code requirements. Wiring in areas with no finished ceilings (exposed construction) shall be exposed overhead such that all raceways are parallel or perpendicular to joists, columns or beams and all drops to wall devices shall be concealed in walls.
- B. Install exposed only where specifically indicated.
- C. Aluminum conduits shall not be installed below grade or in poured concrete or masonry.
- D. Install conduit in accordance with NECA "Standard of Installation."
- E. Install nonmetallic conduit in accordance with manufacturer's instructions.
- F. Arrange supports to prevent misalignment during wiring installation.
- G. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- H. Group Related Conduits:
 - 1. Support using conduit rack of Power-Strut, or approved equal.
 - 2. Parallel runs shall be neatly clustered with all bends and offsets of uniform pattern
 - 3. Provide space on each for 25 percent additional conduit.
- I. Substantially support with approved clips or hangers spaced not to exceed ten feet (10') on centers except 1/2" rigid conduit and 1/2" and 3/4" electrical metallic tubing shall have supports spaced not to exceed six feet (6').
- J. Fasten conduit supports to building structure.
 - 1. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
 - 2. Do not attach conduit to ceiling support wires.
 - 3. Conduits larger than 2" shall be supported from top cord of joists.
- K. Arrange conduit to maintain headroom and present neat appearance.
- L. Route conduit parallel and perpendicular to walls.

- M. Route conduit in and under slab from point-to-point.
 - 1. Install only where specifically indicated or required.
 - 2. Obtain approval from the Architect before installation.
 - N. Do not cross conduits in slab.
 - O. Maintain adequate clearance between conduit and piping.
 - P. Maintain 6 inch clearance between conduit and surfaces with temperatures exceeding 104°F.
 - Q. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes, before burying in trench.
 - R. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
 - S. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction. Use factory elbows or hydraulic one-shot bender to fabricate bends in metal conduit 1 1/2" or larger in size.
 - T. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
 - U. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.
 - V. Provide suitable labeled nylon pull string in each empty conduit.
 - W. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
 - X. Use sleeves when passing through floors and walls.
 - Y. When serving roof top equipment, conduit shall enter within the weather-proof curbing. Maintain water tight roofing system.
 - Z. Ground and bond conduit under provisions of Division 26 Section "Grounding and Bonding."
 - AA. Identify conduit under provisions of Division 26 Section "Electrical Identification."
 - BB. All elbows in nonmetallic conduit runs shall be rigid galvanized steel to eliminate "burn through" when pulling in conductors.
- 3.2 FIELD QUALITY CONTROL
- A. No wire shall be installed until work which might cause damage to wires or conduits has been completed.
 - B. Conduits shall be thoroughly cleaned of water or other foreign matter before wire is installed.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire-resistance rating of partitions and other elements, using approved seals, fillers and materials.

END OF SECTION 260111

SECTION 260123 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Building wire and cable.
- B. Metal clad cable.
- C. Wiring connectors and connections.

1.2 RELATED SECTIONS

- A. Division 26 Section 260010 "Basic Electrical Requirements."
- B. Division 26 Section 260111 "Conduit."
- C. Division 26 Section 260130 "Boxes."
- D. Division 26 Section 260195 "Electrical Identification."

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 N.E.C. Latest Edition.
- C. U.L. Standards.

1.4 DESIGN REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70. (N.E.C.)
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. as suitable for purpose specified and shown.
- C. Conductor Sizes Shown Are Based on Copper:
- D. Manufacturer's name, wire size and insulation type shall be clearly marked on the insulation or jacket.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures."

- B. Include MC manufacturer's specification sheets indicating construction, diameter, ampacity and bending radius.

1.6 PROJECT CONDITIONS

- A. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.
- B. Where wire and cable routing is not shown, and destination or circuit number only is indicated, determine exact routing and lengths required.

1.7 COORDINATION

- A. Locate such that outlets are readily accessible.
- B. Determine required separation between cable and other work.
- C. Determine cable routing to avoid interference with other work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General Cable.
- B. Triangle PWC, Inc.
- C. Superior Essex Inc.
- D. Southwire Company.
- E. Allied Wire & Cable.
- F. Cerro Wire.
- G. AFC Cable Systems.
- H. Encore Wire Corporation.
- I. United Copper Industries.

2.2 WIRE AND CABLE

- A. Description: Single conductor insulated wire.
- B. Conductors: Copper. Insulation Voltage Rating: 600 volts.
- C. Insulation: ANSI/NFPA 70 (N.E.C.), Type THHN/THWN, XHHW rated 90° C.

2.3 METAL CLAD CABLE

- A. Description: ANSI/NFPA 70 (N.E.C.), Type MC with separate insulated ground.
- B. Conductor: Copper, maximum # 10 AWG.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 90° C.
- E. Armor Material: Steel or Aluminum.
- F. Armor Design: Interlocked Metal Armor.
- G. Jacket: PVC, in locations specified in Article 3.03-WIRING METHODS.

2.4 WIRING CONNECTORS

- A. Use the Following Types As Herein Specified:
 - 1. Split bolt connectors.
 - 2. Solderless pressure connectors.
 - 3. Spring wire connectors.
 - 4. Compression connectors.
 - 5. Insulation piercing connectors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRING METHODS

- A. Concealed Dry Interior Locations: Use only wire Type THHN/THWN, and XHHW insulation, in raceway or metal clad cable.
- B. Accessible Dry Interior Locations (such as above acoustical ceilings): Use only wire Type THHN/THWN, and XHHW insulation, in raceway or metal clad cable.
- C. Exposed Dry Interior Locations:
 - 1. Use exposed wiring only where specifically indicated.
 - 2. Use only building wire Type THHN/THWN, and XHHW insulation, in raceway.

- D. Wet or Damp Interior Locations: Use only building wire Type THHN/THWN, XHHW, and XHHW-2 insulation, in raceway.
- E. Exterior Locations: Use only building wire Type THHN/THWN, XHHW, and XHHW-2 insulation, in raceway.
- F. Underground Installations: Use only building wire Type THHN/THWN, XHHW, and XHHW-2 insulation installed in raceway, or Type USE-2 cross-linked polyethylene, designed for direct burial but installed in raceway except as indicated on the Drawings.
- G. Panel and Transformer Feeders: Use only building wire Type THHN/THWN, XHHW, and XHHW-2 insulation, in raceway.
- H. Use other wiring methods only as specifically indicated on Drawings.

3.4 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Except as otherwise specifically noted, all wiring throughout the building, including each of the systems specified, shall be enclosed in raceways.
- C. In general, all wire in raceways and cable shall be concealed above ceilings and within finished walls, securely supported in accordance with code requirements. Wiring in areas with no finished ceilings (exposed construction) shall be raceways exposed overhead, but run along structures such that raceways have minimum visibility and such that all raceways are parallel or perpendicular to joists, columns or beams and concealed in walls.
- D. Use solid conductor for feeders and branch circuits #10 AWG and smaller. At contractors option stranded conductors for #10 AWG and smaller shall be permitted as long as vinyl insulated support crimp-on fork terminals are use for all screw head terminations. Barrel lugs and screw activated compression clamps on back wired devices shall not require crimp-on terminals.
- E. Use stranded conductor for feeders and branch circuits #8 AWG and larger.
- F. Use stranded conductors for control circuits.
- G. Minimum Size Conductors for Power and Lighting Circuits #12 AWG Except as Follows:
 1. Minimum #10 AWG for 120 volt circuits more than 100 feet long.
 2. Minimum #10 AWG for 277 volt circuits more than 230 feet long.
 3. Sizes shall be not less than indicated.
 4. Note: Wire sizes indicated on drawings and schedules are minimum requirements and shall be adjusted to meet the above criteria.
- H. Use conductor not smaller than #14 AWG for control circuits with fusing sized accordingly.
- I. Pull all conductors into raceway at same time.
- J. Use suitable wire pulling lubricant for building wire #4 AWG and larger.
- K. Support cables above accessible ceiling, using spring metal clips or approved cable ties to support cables from structure. Do not support from ceiling suspension system. Do not rest cable

on ceiling panels. Do not drape over ductwork or between bar joists. Wiring shall not be run diagonally and shall be cabled neatly.

- L. Use approved cable fittings and connectors.
- M. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- N. Clean conductor surfaces before installing lugs and connectors.
- O. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- P. Use split bolt connectors, insulation piercing connectors or U.L. approved insulated connectors for copper conductor splices and taps, #6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- Q. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, #8 AWG and smaller.
- R. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- S. Wiring in sleeves passing through fire-rated barriers shall be sealed/filled with approved material to maintain the fire rating.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Division 26 Section 260195 "Electrical Identification".
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.6 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- C. Verify continuity of each branch circuit conductor.
- D. Verify proper operation of each circuit.

3.7 TESTING

- A. For conductors larger than #8AWG, perform Insulation-Resistance Test on each field-installed conductor with respect to ground and adjacent conductors.
 - 1. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable.
 - 2. Take readings after 1 minute and until the reading is constant for 15 seconds.

3. Minimum insulation-resistance values shall not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable.

END OF SECTION 260123

SECTION 260130 - BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wall and Ceiling Outlet Boxes.
- B. Pull and Junction Boxes.
- C. Hinged Cover Cabinet Enclosures.
- D. Terminal Blocks and Accessories.
- E. Multi-Service Flush Floor Boxes.

1.2 RELATED SECTIONS

- A. Division 07 Section "Through Penetration Firestop Systems"
- B. Division 08 Section "Access Doors and Frames"
- C. Division 26 Section 260010 "Basic Electrical Requirements."
- D. Division 26 Section 260111 "Conduit."
- E. Division 26 Section 260141 "Wiring Devices."
- F. Division 26 Section 260170 "Grounding and Bonding."
- G. Division 26 Section 260180 "Equipment Wiring."

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 N.E.C. Latest Edition.
- C. U.L. Standards.

1.4 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".
- B. Include product data for nonmetallic boxes, floor boxes, boxes larger than 12x12x6 inches, and boxes with hinged covers.
- C. Include product data for Flush Floor Device Boxes, plus instructions on installation.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Project Record Documents"
- B. Accurately record actual locations and mounting heights of outlets if not as shown on Drawings, plus pull and junction boxes larger than 12x12x6 inches and boxes used for panel feeders.

1.6 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70. (N.E.C.)
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. as suitable for purpose specified and shown.
- C. Size per N.E.C. Art. 314.
- D. Covers for flush floor devices and poke-through fittings shall meet UL scrub water standards for installation in carpet and tile floors.

1.7 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify locations of wall boxes and outlets in all areas prior to rough-in.
- C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.
- D. Generally pull boxes are not shown on Drawings. Provide as required.

1.8 COORDINATION

- A. Locate such that outlets are readily accessible and do not interfere with other work.
- B. Provide for access panels where required.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: Standard type galvanized steel, minimum four inch square or octagon by 2-1/8 inch deep.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type, three and four inch deep or depth as to coordinate with concrete slab.
 - 3. Single Wall Type: Minimum size, four inch square by 1-1/2 inch deep, except as noted. Provide dry wall plaster rings raised as required to insure flush finish mounting.

4. Ganged Wall Type: Minimum depth 3 inches except as noted, ganged as required under common plate to contain device shown. On 277 volt circuits ganged boxes for switches shall contain only one circuit or provide box with permanent barriers per N.E.C. Art 404-8.

- B. Cast Boxes: Type FS shallow type FD deep cast ferrous alloy.
1. Provide number of threaded hubs as required.
 2. Use in all exterior, damp or exposed in mechanical space.
 3. Provide gasketed cover and accessories by box manufacturer for complete weatherproofing.
 4. In locations where subject to corrosive atmosphere, provide PVC-coated boxes.

2.2 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: Standard type galvanized steel, minimum four inch square or octagon by 2-1/8 inch deep.
1. Sizes up to 12x12x6 inch: Provide screw-type or hinged covers.
 2. Sizes greater than 12x12x6 inch: Provide hinged covers.
- B. Exterior Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box.
1. Material: Galvanized cast iron or Cast aluminum.
 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

2.3 CABINET ENCLOSURES

- A. Covers: Continuous hinge, held closed by flush latch operable by key, finish in gray baked enamel.
- B. Boxes: Galvanized steel minimum 12"x12"x6" deep or as noted. Provide 3/4 inch (19 mm) thick plywood backboard painted matte white, for mounting terminal blocks.
- C. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts.
- D. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw connectors, rated 300 volts.

2.4 MULTI-SERVICE FLUSH FLOOR BOXES

- A. Legrand-Wiremold RFB series four-compartment combination reach-in type fully recessed and concealed floor box. Box shall be capable of providing service fittings for one duplex receptacle or one duplex voice/data outlet for each of four compartments (two data and two power), plus flip-up lid. Include all components as required to provide the devices indicated. Provide blank plates where devices are not used to assure separation between line and low voltage. Minimum components shall include:
1. RFB4-CI-1: Concrete-tight cast iron floor box, nominal 14 1/2"W x 11 7/8"W x 3 7/16"D with one 1" and one 1 1/4" feed thru per compartment. 2" pre-pour adjustability.

2. Floor Port Activation Cover: TopGuard protection from water, dirt and debris. Hinged doors with seals, flanged activation kit with die-cast aluminum trim ring and access hatch. Blank cover assembly; FPBTCAL.
3. Box Accessories: Mounting plate for specific activity inserts and feed through wire management.
4. Floor box mudcap.
5. Where floors require extra depth from concrete to finished floor, such as in the gymnasium, provide a factory fabricated welded box extension ring to allow extra depth between box and access hatch. Extension ring shall have four mounting holes in bottom, one at each corner of the box to secure the ring to the box, plus four threaded holes in the top, one at each corner of the ring to receive the access hatch. Fabricate the extension ring after installation and use field dimensions to assure proper fit. Laminate a 1/8" thick material in the hatch face to match surrounding material.
6. See room finish schedule for floor types.
7. UL listed for use on tile or carpet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
 1. Except where specifically noted, boxes on finished surfaces shall be flush mounted with finished cover plate.
 2. Consult Architect prior to installing in finished areas.
- B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- D. In Non-accessible Ceiling Areas: Install outlet and junction boxes no more than 12 inches from ceiling access panels or from removable recessed luminaires such that they are accessible.
- E. In accessible Ceiling Areas: Install outlet and junction boxes such that they are accessible from ceiling access panels or from removable recessed luminaires.
- F. Install boxes to preserve fire-resistance rating of partitions and other elements, using materials and methods under the provisions of Division 07 Section "Through Penetration Firestop Systems".
- G. Align Wall Boxes for Switches, Receptacles, Thermostats, Telephone, and Similar Devices with Each Other as Follows:
 1. Horizontally for outlets with same mounting height.
 2. Vertically for outlets shown in similar locations with different mounting heights.
- H. Do not install flush mounted boxes back-to-back in walls; provide minimum 6 inch separation. Provide minimum 24 inches separation in acoustic and fire rated walls.
- I. Accurately position flush mounted wall boxes to allow for surface finish thickness.
 1. Box shall be flush with finished surface.

2. Use wall box support brackets that span two studs.
 3. Single stud support will be allowed only if used with Caddy H series E-Z Mount Brackets are used.
-
- J. Install flush mounting box without damaging wall insulation and vapor barrier or reducing its effectiveness.
 - K. Use adjustable steel channel fasteners for hung ceiling outlet box.
 - L. Do not fasten boxes to ceiling support wires.
 - M. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
 - N. Use gang box where more than one device is mounted together. Do not use sectional box.
 - O. Use 4" square box with plaster ring for single device outlets.
 - P. Use cast outlet box in exterior locations exposed to the weather and wet locations.
 - Q. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
 - R. Set floor boxes level.
 - S. Large Pull Boxes: Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.
 1. Interior Dry Locations: Use hinged covers.
 2. Other Locations: Use surface-mounted cast metal box.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations and sizes of required access doors with Division 08 Section "Access Doors and Frames".
- B. Coordinate masonry cutting to achieve neat opening.
- C. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.
- D. Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

3.3 ADJUSTING

- A. Adjust floor box flush with finish flooring material.

END OF SECTION 260130

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SECTION 260141 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wall Switches.
- B. Wall Dimmers.
- C. Receptacles.
- D. Device Plates.
- E. Lighting Sensors.
- F. Relays and Contactors.

1.2 RELATED SECTIONS

- A. Division 07 Section "Penetration Firestopping".
- B. Division 26 Section 260010 "Basic Electrical Requirements".
- C. Division 26 Section 260130 "Boxes."

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 N.E.C. Latest Edition.
- C. U.L. Standards.

1.4 SUBMITTALS

- A. Submit Shop Drawings for equipment and component devices in accordance with Division 01 Section "Submittal Procedures".
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Include documentation showing compliance with UL, Fed. Spec. and NEMA references.

1.5 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Cooper; 5351 (single), 5352 (duplex).
 2. Hubbell; HBL5361 (single), CR5352 (duplex).
 3. Leviton; 5891 (single), 5352 (duplex).
 4. Pass & Seymour; 5381 (single), 5352 (duplex)
- B. Device Body:
1. Devices shall be White.

2.3 TAMPER RESISTANT (CHILD SAFETY TYPE) STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Receptacles shall have a visible mark ("TR") to identify the receptacle as tamper resistant.
1. Hubbell BR15TR series with integral internal safety shutter.
- B. Device Body:
1. Devices shall be White.

2.4 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped. Will not energize if line and load wiring are reversed. In all locations where children may be present receptacles shall have a visible mark ("TR") to identify the receptacle as tamper resistant.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Hubbell; GFTR15
- C. Device Body:
1. Devices shall be White.

2.5 WALL SWITCHES (Momentary Type)

- A. Manufacturers:
1. Hubbell LV Series Model number listed except as noted.
 2. Approved equal.

- B. Hubbell: LVSM1PL, Low voltage momentary, available one through four buttons.
- C. Device shall be White.

2.6 WALL SWITCHES (Toggle Type – For Use in Mechanical Room and Showers)

- A. Switches, 120/277V, 20A:
 1. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 2. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 3. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 4. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way)
- B. Device shall be White.

2.7 LIGHTING SENSORS

- A. Manufacturers:
 1. Hubbell OMNI series. Model numbers listed except as noted.
 2. Lightolier
 3. Light-O-Matic
 4. Sensor Switch
 5. Leviton
 6. ETC
- B. Complete with Faceplates, Color: White except as noted.
- C. Sensor - Room Ceilings (12' Maximum mounting height): Hubbell OMNIDT2000 360deg. dual technology ceiling mounted sensor with isolated relay.
 1. 24 VDC/VAC
 2. Ultrasonic frequency of 40kHz
 3. Time delays: Set units for 15 minute delay to OFF.
 4. Low voltage, momentary switch input for manual operation
 5. Isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC
 6. Coverage: 500-2,000 sq.ft.
 7. UL and CUL listed; Five year warranty
 8. Provide control units (power packs) UVPPM, mounting brackets and other hardware as required for a complete working system to cover the areas indicated.
- D. Sensor – Assembly Hall (ceiling heights from 10-40'): ETC EOCC-HCM 360deg. passive infrared ceiling mounted sensor.
 1. 24 VDC/VAC
 2. Ultrasonic frequency of 40kHz
 3. Time delays: Set units for 15 minute delay to OFF.
 4. Low voltage, momentary switch input for manual operation
 5. Coverage: 350-7,000 sq.ft.
 6. UL and CUL listed; Five year warranty
 7. Provide control units (power packs) UVPPM, mounting brackets and other hardware as required for a complete working system to cover the areas indicated.
 8. Color: Black.

2.8 LED WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton IP710-DL - Illuma Tech Slide Dimmer (0-10volt) Series except as indicated
 - 2. Lutron
 - 3. Lightolier
 - 4. Lithonia
- B. Plastic with linear slide and ON/OFF button.
- C. 1200VA, 120/277 Volt AC 60Hz, Single-Pole & 3-Way, IllumaTech Preset Electro-Mechanical Electronic 0-10VDC Slide Dimmer with LED Locator Light.
- D. Power circuit shall pass through dimmer ON/OFF button to Ballast or LED driver, plus separate pair of 0-10volt low voltage wires to dimming ballast or driver.
- E. Push button switch shall acts as an air-gap switch completely disconnects power to dimming ballast or driver to allow for fixture service.
- F. Power failure recovery shall ensures retention of last setting before power interruption.
- G. Switch shall be compatible with lighting fixture driver.

2.9 WALL PLATES

- A. Decorative Cover Plate: Series 97000 stainless steel USD-32 with satin finish.
- B. Rain-Tight While-in-use Cover Plates: NEMA 3R Clear cover extra deep, Leviton 5966-DCL Series.
- C. Utility Area Cover Plates for Surface Mounting: Cadmium plated steel with rounded edges.

2.10 RELAYS/CONTACTORS, AND TIME CLOCK CONTROLS

- A. Similar to the following with characteristics as indicated or equal:
- B. Control Relays: Allen-Bradley Bulletin "700" Series.
 - 1. 120 volt coil as required.
 - 2. Number of poles as indicated or required. Minimum number of poles: two.
 - 3. Minimum continuous ampere rating: 5 amps.
 - 4. Enclosure: NEMA-1, except as noted.
 - 5. Electrically held, except as noted.
 - 6. 600 volt rated.
 - 7. For non-lighting low voltage control applications.
- C. Lighting Relays/ Contactors: Allen-Bradley Bulletin "500L" Series.
 - 1. 120 volt coil as required.
 - 2. Number of poles as indicated or required. Minimum number of poles: two.
 - 3. Minimum continuous ampere rating: 125 percent of the connected load, except minimum 20 amps.
 - 4. 600 volt rated.

5. Enclosure: NEMA-1, except as noted.
 6. Electrically held, except as noted.
 7. Rated for lighting and heating loads.
- D. Motor Load Relays/Contactors: Allen-Bradley Bulletin "500" Series.
1. 120 voltcoil as required.
 2. Number of poles as indicated or required. Minimum number of poles: three.
 3. Horsepower rated for connected motor, except minimum NEMA size 0.
 4. 600 volt rated.
 5. Enclosure: NEMA-1, except as noted.
 6. Electrically held, except as noted.
- E. Exterior Lighting Time Control: See Division 26 Section 260149 "Lighting Control System".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices and plates vertical and plumb. Boxes shall be flush with finished surface.
- C. Provide matching blank face plate for all unused wall boxes.
- D. Installation of switches:
1. Locate close to door frame on latch side of door, or beyond swing of door where appropriate.
 2. Where door frames have side lights, switch shall be either located below side light where a 3'-0" mounting height is possible, or beyond the side light. Coordinate with door frame schedule.
 3. Switches indicated in the same area at the same mounting heights shall be ganged together under a common plate.
- E. Install wall dimmers to achieve full rating specified. Do not break off cooling fins. Mount in separate gangs as required.
- F. Installation of lighting sensors shall require manual on and automatic off of lighting.
- G. Do not share neutral conductor on load side of dimmers.
- H. Install receptacles with grounding pole on top.

END OF SECTION 260141

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SECTION 260149 – LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pre-wired, microprocessor controlled relay panels with electrically held, electronically latched relays and dimming panels controlled via a complete list of communication based accessories including but not limited to, all wiring, digital switches, digital photocells, day-lighting sensors, Digital Time Clock (DTC) and interface cards, building automation systems, thermostats, and other contact closure or analog based devices and programming for a complete system.
- B. Low Voltage panels, complete with relay/dimmer modules, cards, interiors
- C. Low Voltage switches and faceplates.
- D. Dataline Communications Network.
- E. Communications Interface and software to program and operate the system via the owner furnished PC.
- F. Interface to telephone access overrides.
- G. All programming, testing, training and performance of all operations of the intelligent system as indicated on the drawings and as herein specified.
- H. Daylight Harvesting System with accessories.
- I. See Section 260141 "Wiring Devices" for lighting vacancy sensors.

1.2 RELATED SECTIONS

- A. Section 260010: Basic Electrical Requirements.

1.3 SUBSTITUTIONS

- A. Refer to Division 01 for Substitutions and Product Options.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by a nationally recognized testing laboratory such as Underwriters' Laboratories, Inc. or ETL as suitable for purpose specified and shown.
- C. Include all necessary software, programming and the selection of the proper type and quantities of the system components to assure a complete, operational, and Code Compliant System.

- D. Provide the Owner with all required components, interfaces, passwords and training to allow them full access to the programming features. See Part 3 of this Section for training and field services.
- E. The drawings do not show all details of the System. It shall be the responsibility of the authorized supplier/installer to provide a fully operational system.
- F. Special programming requirement:
 - 1. Any OFF command from the central system and or by a remote “out of sight” local switch shall cause a flicker event with 5 minutes delay before commanding the lighting to OFF. If an ON command is initiated during the delay, then lighting shall remain ON for two hours before initiating another OFF command.
- G. Programming and control shall be from the owner furnished PC running MS-Windows/Mac OS operating system. Lighting Control Software provided under Section 260149. Central programming software shall permit multiple users to access the lighting control system simultaneously. Coordinate with owner and provide all work required to install and program the Software as well as output ports, modems and communication lines for a complete functioning system.

1.5 PROJECT CONDITIONS

- A. Low Voltage wire and cable routing is not shown on the Drawings. Route wire and cable and determine exact lengths as required to meet project conditions.

1.6 SPARES PARTS

- A. Provide minimum of two low voltage replacement switches.
- B. Provide two spare low voltage lighting control stations.

1.7 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing the products specified in this Section with minimum five years documented experience.
 - 2. Company maintaining engineering and service departments capable of rendering advice regarding installation, programming and final adjustment of the system.
- B. Manufacturer and/or Supplier/Installer (Vendor):
 - 1. Company authorized by the manufacturer with minimum five years experience.
 - 2. Company offering Start-up, training, Documentation, Programming, and extended service contracts for continuing factory authorized service after the initial warranty period.

1.8 SUBMITTALS

- A. Submit Shop Drawings for equipment and component devices in accordance with Division 01 Section “Submittal Procedures”.
- B. Product Data: Submit manufacturer's data on lighting control system and all components.

- C. Shop Drawings: Submit dimension Drawings of all lighting control system components and accessories.
- D. Typical Wiring Diagrams: Submit typical wiring diagrams for all components including, but not limited to, relay panels, relays, dimmer modules, low voltage switches, Boosters, Photocells, Day Lighting Sensors.
- E. See Part 3, DOCUMENTATION for additional requirements.

1.9 SYSTEM DESCRIPTION

- A. The lighting control system shall be a networked system that communicates via RS485. The system shall be able to communicate with fully digital centralized relay panels, micro relay panels with 0-10VDC dimming outputs, digital switches, photocells, daylight sensors, various interfaces and shall include all operational software. The intent of the specification is to integrate lighting control into one system, except for areas controlled by standalone daylight harvesting systems, and motion sensor controlled fixtures. Distributed lighting control shall be provided using networked relay panels. Centralized relay panels shall control corridors, common areas, and site lighting. Lighting control system shall include all hardware and software. Software shall be resident within the lighting control system. System shall provide local access to all programming functions at the master lighting control panel (LCP) and remote access to all programming functions via dial up modem and through any standard computer workstation. Lighting control system shall have the capability to be remotely controlled via the internet or building wide Ethernet LAN.
- B. System software shall provide real time status of each relay, each zone and each group.
- C. Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line all system programming uploaded to the lighting control system shall continue to operate as intended.
- D. All devices shall be pre-addressed at the factory.
- E. All programs, schedules, time of day, etc, shall be held in non-volatile memory for a minimum of 10 years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date. Time of day shall be battery backed for at least 10 years.
- F. System shall be capable of warning of an impending "OFF" sweep by flashing lights Off/On once or twice (programmable) by relay or by zone prior to the lights being turned off. The warning interval times between the flash and the final lights off signal shall be definable for each zone. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and not exceed 2-hours.
- G. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, specification grade line voltage type wall switches, photocell, web based software or other devices connected to programmable inputs in a lighting control panel.
- H. The lighting control system shall provide the ability to control each relay and each relay group per this specifications requirement. All programming and scheduling shall be able to be done locally at

the master LCP and remotely via dial up modem and via the Internet. Remote connection to the lighting control system shall provide real time control and real time feedback.

- I. System shall consist of centralized relay panels, micro relay panels, digital switches, photocells and various digital interfaces. Verify exact components specified. Micro relay panels, centralized relay panels and digital switches shall communicate as one network via RS485. Micro relay panels, mounted in each local area, shall control all lighting fixtures in that space, provide power to occupancy sensors and take input from daylight sensor and occupancy sensors. Micro relay panels shall be capable of taking inputs from standard, line voltage type switches and outputting up to 8 independent 0v to 10v dimming signals. All micro relay panels and all devices connected to micro relay panels (switches, photocells and occupancy sensors, etc) shall be wired per lighting control manufacturers instructions.
- J. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems, Article 725 and manufacturer specification.
- K. Lighting control panels (LCPs) shall be UL 916 listed..
- L. Lighting control system shall be digital and consist of a master LCP with up to 48 individual relays, slave LCPs with up to 48 individual relays in each panel, digital switches and digital interface cards. All system components shall connect in a "daisy chain" style configuration and be controlled via category 5 patch cable with RJ45 connectors, providing real-time two-way communication with each system component.
- M. Relay panels shall be pre-wired, pre-assembled, and preprogrammed.
- N. Standard relays shall have contacts rated for 120/277v 20a tungsten, ballast or HID. Standard relays shall be zero-cross type. For site lighting, relays shall be 600V, 2-Pole relay, NO OR NC, rated minimum 20A.
- O. Relay panel electronics shall provide current visual status and control of each relay or zone. All system control electronics shall store programming in a non-volatile memory and provide 10 year battery back up for time of day.
- P. Lighting control system interfaces shall include a dry contact input interface, BMS (building management system) interface, dimming system interface, ethernet/internet interface and an interface to smart-breaker panel boards. Provide all interfaces required to perform as indicated on the drawings and specifications.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Lighting Control & Design (Numbers & system specified except as noted).
- B. Lutron.
- C. Seimens.

- D. Leviton.
- E. Sensor Switch.
- F. WattStopper.
- G. Nexlight.
- H. Lithonia.
- I. Lightolier.
- J. ETC Architectural Control Systems.
- K. Hubbell Building Automation.
- L. Crestron Electronics.
- M. Encelium.

2.2 RELAY PANELS SHALL CONSIST OF THE FOLLOWING:

- A. Relay Panels:
 1. NEMA 1 rated enclosure with hinged door.
 2. 16 AWG steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120v and 277v.
 3. LCP input power shall be capable of accepting 120v or 277v without rewiring
 4. Control electronics in the low voltage section shall be capable of driving 2 to 48 relays, control any individual or group of relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each relay and every zone, and be able to control Normally Open (NO) or Normally Closed (NC) relays.
 5. All system components shall connect and be controlled via a single Category 5, 4 twisted pair cable, providing real time two-way communication with each system component.
 6. Panels used for life safety lighting shall be in separate enclosures from the normal panels to isolate the emergency circuits and shall have fail safe NC contacts to assure lighting is forced "ON" during power failure by monitoring the local normal circuit.
 7. Low Voltage Relay Panels shall be equal to LC & D GR 2400 Series.
- B. Micro Relay Panels:
 1. Micro relay panels shall have up to 8-30a, 18,000 SCCR rated lighting relays and shall control all lighting in the designated area indicated on the plans and shall have the ability to be networked to centralized relay panels, micro relay panels, smart breaker panels, digital switches, photocells, various interfaces. Each micro relay panel shall provide minimum 300ma at 12/24vdc for powering occupancy sensors.
 2. Micro relay panel shall provide a minimum 4-programmable photocell inputs, a minimum 4-programmable occupancy sensor inputs and matrixed contact closure inputs.
 3. Micro relay panels shall be capable of outputting minimum 4 and up to 8 independent 0v to 10v dimming signals, one independent dimming signal at each of 8 relays. In order to maximize daylight harvesting and minimize disruption to occupants, each dimming output

shall provide adjustment for baseline, start point, mid point, end point, trim, fade up rate, fade down rate, time delay and enable/disable masking. All photocell settings shall be remotely accessible.

C. Standard Output Relays:

1. Electrically held, electronically latched SPST relay.
2. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two (2) #10AWG wires on both the line and the load side.
3. Rated at 20 Amp, 277VAC Ballast, Tungsten, HID, 1 HP at 120 Vac, 2 HP at 240 Vac.
4. Relays to be rated for 250,000 operations minimum at 20a lighting load, use Zero Cross circuitry and be Normally Closed (NCZC). All incandescent circuits shall be energized by use of a Normally Closed SoftStartT (NCSS) relay rated at 100,000 operations at full 20a load.
5. Optional relay types available shall include: Normally Open (NO) relay rated for 100,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

D. Low Voltage Switches:

1. All switches shall communicate via RS 485, CAT 5 patch cable with RJ45 connectors. Any switch button function shall be able to be changed locally (at the DTC or at the PC) or remotely, via modem, Ethernet or Internet.
2. Switches shall be available in 1 through 6-button version with engraveable buttons, red LED annunciation for each button and a constantly On green LED locator.
3. Digital low voltage switch shall be a device that sits on the lighting control system bus. Digital switch shall connect to the system bus using the same cable and connection method required for relay panels. Each button shall be capable of being programmed for On only, Off only, Mix (Some on some off), On/Off (toggle), Raise (Dim up) and Lower (Dim down). Each button shall be able to be enabled or disabled over the bus.
4. Switches shall be capable of handling electrostatic discharges of at least 30,000 volts (1cmspark) without any interruption or failure in operation.

E. Switches/Plates:

1. Similar to LC&D GR 2400 Series Chelsea switches. Group the switches shown in close proximity under a common face plate.
 - a. Single gang from 1 to 6 buttons.
 - b. Programmable via TDC programmer and via MS-Windows Lighting Control Software in ATC PC.
 - c. RS 485 bus protocol.
 - d. Built-in RJ45 connectors (in & out).
 - e. Standard decorator style face plates.
 - f. Provide matched Specification Grade plates of materials and colors to match devices specified under section 260141.

F. DTC - Digital Electronic Time Clock:

1. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept interface inputs.
2. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.

3. The DTC shall be capable of controlling up to 127 digital addresses on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.
4. The DTC shall accept control locally using built in button prompts and use of a 8 line 21-letter display or from a computer or modem via an on-board RS 232 port. All commands shall be in plain English. Help pages shall display on the DTC screen.
5. The DTC shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 10 years with loss of power.
6. System shall come with a Pre-Installed modem that allows for remote programming from any location using a PC. Modem shall include all necessary software for local or remote control.
7. DTC shall provide system wide timed overrides. Any relay, group or zoned that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.
8. Unity™ lighting control software shall provide via local or remote PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. System shall include the optional Unity GX lighting control software. Unity GX shall provide for importing vector based graphics and a simple interface that allows users or a factory programmer to overlay color “controls” that are associated with relays or collections of relays. Clicking on the overlays changes the color and the status of the relays for visual display of large systems.

G. Photocells:

1. Photocells used for exterior lights shall provide multiple trip points from 1 roof mounted unit. All trip points shall be able to be changed remotely via Internet or dial up modem.
2. Photocells used for interior lighting control shall have multiple settings such as start-point, mid-point, off-point, fade-up, fade-down, etc. All settings shall be remotely accessible and adjustable.
3. Photocell, exterior (PCO) or interior (PCI), shall provide readout on the DTC screen in number values analogous to foot-candles. Each photocell shall provide a minimum of 14 trigger points. Each trigger can be programmed to control any relay or zone. Each trigger shall be set through DTC, locally or remotely.
4. Photocell Controls (low voltage lighting control system daylight sensor): Provide Photocell Controllers as required to support the daylight harvesting system. Photocells shall be similar to the following and compatible with the system specified: LC&D model iPC-L.

H. Provide the following Interfaces:

1. A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card.
2. Interface card providing digital communication from one system bus to another system bus, allowing up to 12,000 devices to communicate.
3. An exterior (PCO) and interior (PCI) photocell that provides readout on the DTC screen in number values analogous to foot-candles. Each photocell shall provide a minimum of 14 trigger points. Each trigger can be programmed to control any relay or zone. Each trigger shall be set through programming only.
4. A voice prompted telephone override interface module. Interface module shall accept up to 3 phone lines and allow up to 3 simultaneous phone calls. Voice prompted menu and up to 999 unique pass codes shall be standard with each interface module.

2.3 DIMMING BALLAST

- A. 0-10Volts dimming ballast - Advance Mark 7 or equal and 0-10v LED dimming drivers. Coordinate with lighting manufacturer's for compatible units.
- B. See also Section 270510 – Luminaires.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 260141.
- B. Mount relay control cabinets adjacent to respective lighting panelboard. Cabinet shall be surface mounted. Wiring between relay control cabinet and panelboards shall be per local codes and acceptable industry standards. Neatly lace and rack wiring in cabinets. During construction process, protect all interior components of each relay panel and each digital switch from water, dust and debris.
- C. Switches: Provide outlet boxes, single or multi-gang, as required for the low voltage digital switches. Mount switches as indicated. Provide faceplates and the required low voltage cable, Category 5, 4 twisted pair, with pre-assemble RJ45 connectors and snagless boots (commonly referred to as a Cat 5 patch cable) between all switches and panels. Field-test all Cat 5 patch cable with a recognized cable tester. All low voltage wire shall be run in EMT or ENT or as specifically indicated on the drawings.
- D. Provide a crimping kit with sufficient approved EZ Brand RJ 45 connectors to populate the whole system. Include a manual that shows all the pitfalls of crimping RJ 45s and instructions on how to properly terminate the connectors.
- E. Wiring:
 - 1. Do not mix low voltage and high voltage conductors in the same conduit.
 - 2. Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.
 - 3. Place manufacturer supplied "terminators" at each end of the system bus per manufacturer instructions.
 - 4. Neatly lace and rack wiring in cabinets.
 - 5. Plug in Category 5, 4-twisted pair cable that has been field tested with a recognized cable tester, at the indicated RJ45 connector provided with each lighting control device, per manufacturer instructions.
 - 6. Use Category 5, 4 twisted pair cable for all system low voltage connections. Additional conductors may be required to compensate for voltage drop with specific system designs. Contact LC&D or refer to the GR2400 manual for further information.
 - 7. Use shielded cable for dry contact inputs to lighting control system.
 - 8. Do not exceed 4,000 ft-wire length for the system bus.
 - 9. All items on the bus shall be connected in sequence (daisy chained).
 - 10. All wiring shall be per manufacturer's instructions.

3.2 SEQUENCE OF OPERATION

- A. System shall be initially set up to perform the following:
 - 1. Daylight Harvesting System:
 - a. Balanced dimming between lighting zones bases on the level of outside lighting contribution.
 - b. Provide zones as indicated on E10 series drawings as indicated by “z#” adjacent to each fixture requiring daylight harvesting.
 - c. Separate ON/OFF control from Wall Control Station of each lighting zone.
 - d. Manual dimming override lighting level from Wall Control Station by lighting zone.
 - e. Manual override to OFF from Wall Control Station.
 - f. Unoccupied: All lights OFF after 15 minutes.
 - g. Sensors shall operate as vacancy type requiring the occupant to turn ON lighting from lighting control station.
 - h. Adjust daylight harvesting to maintain the following lighting levels:
 - 1) Multi-Purpose/Library, Infant, Nursery, Toddler, Pre-K, Art Rooms – 30fc Average measured at 30” AFF.
 - 2) Corridor, Lobby and Vestibule Spaces – 25fc Average measured at floor.
 - 3) Offices – 40fc measured at 30” AFF.
 - 4) Assembly Hall – 35fc measured at floor.
- B. Other features as may be directed by Owner.

3.3 INSTALLATION AND SET-UP

- A. Verify that conduit for line voltage wires enters panel in line voltage areas and conduit for low-voltage control wires enters panel on low-voltage areas. Refer to manufacturer's plans and approved shop drawings for location of line and low-voltage areas. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product acceptability.
- B. For approved line voltage type micro relay panel switches connected to matrixed inputs of the micro relay panel, furnish #18 AWG solid conductors. For all other digital switches provide wiring required by system manufacturer.
- C. For lighting control station digital switches provide wiring required by system manufacturer.
- D. All lighting sensors shall be programmed as “Vacancy Sensors” and shall require manual “ON” and auto/manual “OFF”.
- E. Contractor shall test all low voltage cable for integrity and proper operation prior to turn over. Verify with system manufacturer all wiring and testing requirements.
- F. Panels shall be located so that they are readily accessible and not exposed to physical damage.
- G. Panel locations shall be furnished with sufficient working space around panels to comply with the National Electric Electrical Code.
- H. Panels shall be securely fastened to the mounting surface by at least 4 points.
- I. Unused openings in the cabinet shall be effectively closed.

- J. Cabinets shall be grounded as specified in the National Electrical Code.
- K. Lugs shall be suitable and listed for installation with the conductor being connected.
- L. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- M. Maintain the required bending radius of conductors inside cabinets.
- N. Clean cabinets of foreign material such as cement, plaster and paint.
- O. Distribute and arrange conductors neatly in the wiring gutters.
- P. Follow the manufacturer's torque values to tighten lugs.
- Q. Before energizing the panelboard, the following steps shall be taken:
 - 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.
 - 2. Remove shipping blocks from component devices and the panel interior.
 - 3. Remove debris from panelboard interior.
 - 4. Follow manufacturers' instructions for installation and all low voltage wiring.
- R. Service and Operation Manuals:
 - 1. Submit operation and service manuals. Complete manuals shall be bound in flexible binders and data shall be typewritten.
 - 2. Manuals shall include instructions necessary for proper operation and servicing of system and shall include complete wiring circuit diagrams of system, wiring destination schedules for circuits and replacement part numbers. Manuals shall include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built coding used on cables. Programming forms of systems shall be submitted with complete information.

3.4 DOCUMENTATION

- A. Each relay/dimmer module shall have an identification label indicating the originating branch circuit number and panelboard name along with the relay number. Each line side branch circuit conductor shall have an identification tag indicating the branch circuit number.
- B. Provide a point-to-point wiring diagram for the entire lighting control system. Diagram shall indicate exact mounting location of each system device. This accurate "as built" shall indicate the loads controlled by each relay/dimmer module and the identification number for that module, placement of switches and location of photocell. Placed copy of drawing inside the door of each LCP.

3.5 SUPPORT SERVICES

- A. Start Up: Contact LC&D at least 7 days before turnover of project. LC&D shall remotely dial into the lighting control system, run diagnostics and confirm system programming. Contractor shall be available at the time of dial in to perform any corrections required by LC&D. Coordinate with the

owner for the installation of a dedicated telephone line or a shared phone line with an automatic Fax/Modem switch. Phone jack shall be mounted within 12" of Master LCP. Label jack with phone number. Connect phone line from jack to Master LCP.

- B. Telephone factory support shall be available at no additional cost both during and after the warranty period. Factory shall pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified manufacturer, at no added cost, shall provide additional remote programming via modem as required for as long as a phone line is available for the life of the system. Manufacturer shall provide remote dial up software at no added cost.
- C. Manufacturer's Field Services.
 - 1. Provide the services of a factory authorized technical representative of the manufacturer of the equipment to supervise the installation and final connections, plus adjusting, programming and all testing of the system required to assure a complete and fully operative system and to instruct designated personnel in the operation, adjustment, testing and maintenance of the system.
 - 2. Inspect final connections to units prior to energizing system.
 - 3. Perform field inspection and testing.
- D. Provide initial programming as required to activate local switches. Adjust scheduling as directed by Owner.

3.6 FACTORY COMMISSIONING – DAYLIGHT HARVESTING SYSTEM

- A. Upon completion of the installation, the system shall be completely commissioned by factory trained and authorized service personnel.
- B. The commissioning shall be performed after the electrical contractor ensures the system installation is complete and that all loads have been tested live for continuity and freedom from defects.
- C. The system shall be capable of being programmed through the use of a handheld device transmitting IR or PC with lighting management software. The system diagnostics shall include:
Setting lighting zones and device responses to sensor or control input.
- D. Upon completion of the system check-out, the installer/programmer shall demonstrate the operation of the system to the appropriate owner's representatives.

3.7 FACTORY COMMISSIONING – LIGHTING CONTROL SYSTEM

- A. Provide factory-certified field service engineer to make minimum of four site visits to ensure proper system installation and operation under following parameters:
 - 1. Qualifications for factory-certified field service engineer:
 - (a) Minimum experience of 2 years training in the electrical/electronic field.
 - (b) Certified by the equipment manufacturer on the system installed.
 - 2. Make first visit prior to installation of wiring. Review:
 - (a) Low voltage wiring requirements.
 - (b) Separation of power and low voltage/data wiring.
 - (c) Wire labeling.
 - (d) Information required on load schedules.
 - (e) Switching panel locations and installations.

- (f) Control locations and addressing.
 - (g) Analog phone line requirements and computer jack location.
 - (h) Load circuit wiring.
 - (i) Connections to other equipment.
3. Make second visit upon completion of installation of lighting control system:
 - (a) Verify connection of power feeds and load circuits.
 - (b) Verify connection and location of controls.
 - (c) Energize panel and download system data program.
 - (d) Verify proper connection of panel low voltage and data.
 - (e) Verify system operation control by control, circuit by circuit.
 - (f) Verify proper operation of manufacturers interfacing equipment.
 - (g) Verify proper operation of installed programs.
 - (h) Verify operation of PC modem and test dial-up access.
 - (i) Obtain sign-off on system functions.
 4. Make third visit upon completion of installation of lighting control system to demonstrate and educate (train) the owner's representatives on the system capabilities, operation and maintenance.
 5. Make fourth visit six months after substantial completion of installation of lighting control system to re-train the owner's representatives on the system capabilities, operation and maintenance.

3.8 ON SITE TRAINING

- A. Provide a factory technician for on-site training of the owners' representatives and maintenance personnel.
- B. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, commissioning of the lighting control system, and Owner instruction includes:
 1. Demonstrate entire system operation and communication to each device.
 2. Demonstrate operation of individual relays, switches, occupancy sensors and daylight sensors.
 3. Confirmation of system Programming, photocell settings, override settings, etc.
- C. Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.
- D. Minimum training sessions: Two 4 hour period. One at substantial completion and one 6 months thereafter.

END OF SECTION 260149

SECTION 260170 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.

1.2 RELATED SECTIONS

- A. Division 03 Section "Concrete Reinforcement."
- B. Division 03 Section "Cast-In-Place Concrete."
- C. Division 26 Section "Basic Electrical Requirements."

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 (N.E.C.) Latest Edition.

1.4 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: Conform to requirements of ANSI/NFPA 70. (N.E.C.), except that the maximum system resistance shall be 5 ohms.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".
- B. Product Data: Provide data for grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Manufacturer's Instructions: Include instructions for protection, examination, preparation and installation of exothermic connectors.

1.6 GROUNDING ELECTRODE SYSTEM

- A. All connections shall be made by exothermic weld. Connections to thin water pipe shall be made by accessible clamp.

- B. Metal underground water pipe.
- C. Minimum 4/0 copper home run from switchboard to concrete-encased electrode in building footings.
- D. Ground ring at transformer pad.
 - 1. 4/0 bare copper direct buried 3'-0" continuous around pad at 4'-0" beyond pad.
 - 2. Ground rod at each corner and one in pad hand hole.
 - 3. Extend ring with #4/0 to building main switchboard. Do not connect ring to ground rod in pad hand hole.
- E. Metal structure of the building.
- F. Concrete-encased electrode in building footings.
- G. Rod electrode.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Project Management and Coordination".
- B. Accurately record actual locations of grounding electrodes.

PART 2 - PRODUCTS

2.1 ROD ELECTRODE

- A. Manufacturers:
 - 1. Erico, Eritech copper bonded ground rod.
 - 2. Substitutions: Under provisions of Division 01 Section "Substitutions and Product Options".
- B. Material: Copper-clad carbon steel.
- C. Diameter: 3/4 inch.
- D. Length: Sectional 10 feet.

2.2 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. Erico, Cadweld.
 - 2. Continental Industries, thermOweld.
 - 3. Burndy, BURNDYWeld.
 - 4. Substitutions: Under provisions of Division 01 Section "Substitutions and Product Options".

2.3 WIRE

- A. Material: Copper.
- B. Foundation Electrodes: #4/0 AWG.

- C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements, but not smaller than indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install rod electrodes at locations indicated and as required. Install additional rod electrodes as required to achieve specified resistance to ground.
- C. Install ground wire from water entrance to main service entrance. Provide additional ground wire from main service to building structural steel and 25 feet of 1/2" minimum re-bar or 4/0 copper conductor in concrete footing, as required by NEC. Enclose wire in PVC-40 where exposed.
- D. Equipment Grounding Conductor: Provide separate, 600 volt insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- E. Provide and install equipment grounding conductor to each item of electrical equipment.
- F. Equipment grounding conductors shall be continuous where possible. Where splices are required, provide T & B, or approved equal, compression connectors of approved pattern. Insulate connectors to equivalent thickness of conductors.
- G. Provide grounding system for neutrals of dry type transformer secondaries as indicated and required.
- H. Bond together metal siding not attached to grounded structure; bond to ground.

END OF SECTION 260170

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SECTION 260180 - EQUIPMENT WIRING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment specified under other Sections or furnished by Owner, including but not limited to: exhaust fans, air handling units, air-conditioning units, circulators, heating system pumps, burner, home economics, art, industrial art, etc...
- B. All line voltage wiring including final branch circuit connections to disconnects, motor controllers, Variable Frequency Drives (VFD), Isolation transformers, and motors. See Equipment Schedules on Drawings for wiring and plans for equipment locations.
- C. Fused and non-fused disconnect switches for the equipment, except disconnect switches specifically provided with the equipment.
- D. Except as specifically noted, motors, variable frequency drives (VFD), isolation transformers for VFD, magnetic or manual starters and thermal overload protection will be furnished with the equipment for installation under Division 26 Section 260180.
- E. Single pole switches, switch and pilots, and light/fan switches shall be provided and installed under Division 26 Section 260180. Coordinate with equipment schedules on H&V Drawings.
- F. Temperature Control Wiring: Provided and installed under Division 23 Section "Instrumentation and Control for HVAC Systems".

1.2 RELATED SECTIONS

- A. Division 01 Section "Summary".
- B. Division 08 "Openings".
- C. Division 11 "Equipment"
- D. Division 14 Section "Hydraulic Elevators".
- E. Division 22 Section "Plumbing".
- F. Division 23 "Heating Ventilation and Air Conditioning".
- G. Division 26 Section "Basic Electrical Requirements".

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 (N.E.C.) Latest Edition.

- C. U.L. Standards.
- D. ANSI Standards.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70. (N.E.C.)
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- C. Drawings do not show all required disconnect servicing switches. Furnish and locate as required by N.E.C.
- D. Size fuses and thermal elements per N.E.C. and manufacturer's recommendations.
- E. Connect motors for correct voltage, phase and rotation.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".
- B. Include disconnect devices.

PART 2 - PRODUCTS

- 2.1 DISCONNECT SWITCHES: Specified under Division 26 Section 260440.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 PREPARATION

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.3 INSTALLATION

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment, but in no case less than the wire specified under Division 26 Section 260123 "Wire and Cable."

- B. Conduit Connections to Equipment: Dry locations, use flexible conduit. Damp or wet locations, use flexible liquidtight Type UA conduit with approved liquidtight fittings. Maximum length two feet (2').
- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Semiportable Machines: Use heavy-duty oil-resistant type SO cord with stranded copper conductors No. 12 AWG, minimum size and number of wires as required to include each phase conductor, white neutral conductor, and green grounding conductor. Furnish and install Kellems Series H cord grips and spring hangers for each cord connected machine with overhead supply.
- F. Make wiring connections in wiring compartment of prewired equipment in accordance with manufacturer's instructions.
- G. Install disconnect switches, controllers, control stations, temperature switches as indicated or required.

END OF SECTION 260180

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SECTION 260195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates and Tape Labels.
- B. Wire and Cable Markers.
- C. Conductor Color Coding.

1.2 RELATED SECTIONS

- A. Division 09 Section "Painting".
- B. Division 26 Section 260010 "Basic Electrical Requirements."

1.3 REFERENCES

- A. NFPA 70 (N.E.C.) Latest Edition.

1.4 REQUIREMENTS

- A. Label all panelboards plus circuits on all spaces of switchboards and distribution panels, all safety switches, controls, relays, junction boxes, pull boxes, pilot lights, special switches and outlets. Label on panelboards shall include name and circuit number of source.
- B. Nameplates shall identify function of device, space controlled, voltage conditions, fuse size, panel serving switch, as indicated or required without abbreviations. Details shall be as approved.
- C. Conform to requirements of ANSI/NFPA 70. (N.E.C.) Art. 200 for grounded neutral conductor, Art. 210 for branch circuits and art. 250 for grounding (bonding) conductor.

1.5 SUBMITTALS

- A. Submit Shop Drawings, in accordance with Division 01 Section "Submittal Procedures".
- B. Only include if details of nameplates, wiring markers and conductor color code are not as specified below.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Nameplates: Engraved three-layer laminated plastic, white letters on a black background.
- B. Tape Labels: Vinyl adhesive tape with 1/4 inch black letters on white background.

- C. Junction Box Labels: Vinyl adhesive tape with 1/4 inch black letters on white background, indicate voltage and circuit.
- D. Wire and Cable Markers: Cloth markers, split sleeve or tubing type.
- E. Fire Alarm Junction Boxes: Paint red (in areas of exposed construction paint only the cover).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install nameplates and tape labels parallel to equipment lines.
- B. Secure nameplates to equipment fronts using screws, or rivets, or adhesive. Secure nameplate to inside face of recessed panelboard doors in finished locations. Secure nameplate to outside face of surface panelboards in unfinished locations.
- C. Use tape labels only for identification of individual wall switches, receptacles, and control device stations.

3.2 WIRE IDENTIFICATION

- A. Conductors throughout the building shall be color coded to identify voltage and phases.
 - 1. All metallic bonding conductors - Green.
 - 2. Insulated Isolated Grounding Conductor: Green with yellow stripe.
 - 3. Phase Conductors of 120/208 Volt System: Black, red, blue. Neutral: white.
- B. All circuit conductors of the same color shall be connected to the same ungrounded feeder conductor throughout the installation.
- C. Where conductors are not available in the colors indicated, due to size, prewired cable, or other reason: Install identifying adhesive bands 3/4" wide of colors indicated above around each conductor within six inches (6") and twelve inches (12") of each end and at a maximum of five foot (5') intervals along wireways, at back of panelboards, and wherever conductors are accessible.
- D. Power and lighting circuits in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection: Provide wire markers on each conductor and Identify with branch circuit or feeder number.
- E. Conductors of different system voltages shall not enter the same raceway, box, gutter, or other types of enclosures.
- F. System control wires at control panel and load connection:
 - 1. Provide wire markers on each conductor and identify with number as indicated on manufacturer's schematic and interconnection diagrams, and equipment manufacturer's Shop Drawings.
 - 2. Fire Alarm System: Follow local Fire Department color code and labeling standards.

END OF SECTION 260195

SECTION 260420 - SERVICE ENTRANCE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Arrangement with Power Company for permanent electric service including payment of Power Company charges for service.
- B. In the electrical filed sub-bid, carry the sum of \$25,000.00 (Twenty Five Thousand Dollars) to pay Power Company excess charges for poles, hardware and equipment, pad mounted transformer, setting of pad transformer, etc... Any changes in the above stated charges will be corrected by an add or deduct change order, based on the net difference without markup after receipt of Power Company bills upon completion of primary work.
- C. Arrange with Power Company to provide for metering.
- D. Underground duct banks, conduits and secondary wires from Power Company pole to pad mounted transformer to service entrance equipment.
- E. Primary service duct banks, conduits and secondary lugs.
- F. Primary cables, aerial and underground lines, poles, switching, fuse protection and pad mounted transformers will be furnished and installed by the Power Company.

1.2 RELATED SECTIONS

- A. Division 03 Section "Cast-In-Place Concrete".
- B. Division 03 Section "Precast Concrete".
- C. Division 26 Section 260010 "Basic Electrical Requirements."
- D. Division 26 Section 260111 "Conduit."
- E. Division 26 Section 260123 "Wire and Cable."
- F. Division 26 Section 260130 "Boxes."
- G. Division 26 Section 260170 "Grounding and Bonding."
- H. Division 31 Section "Earthwork."
- I. Division 32 Section "Paving and Surfacing."

1.3 SYSTEM DESCRIPTION

- A. System Voltage: 120/208 volts, three phase, four wire, 60 Hertz.

- B. Service Entrance: As indicated on Drawings.

1.4 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 (N.E.C.) latest edition.
- C. U.L. Standards.
- D. ANSI Standards.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70. (N.E.C.) and ANSI C2 National Electrical Safety Code.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- C. Power Company: Central Maine Power, contact Paul Duperre tel. (207) 828-2882.
- D. Install in accordance with Power Company's rules and regulations.

1.6 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".
- B. Include meter socket and proof of payment of Power Co. charges.

PART 2 - PRODUCTS

2.1 METERING EQUIPMENT

- A. Intent is that the metering CT's/PT's will be installed by the Power Co. and located within the pad mounted transformer.

2.2 SECONDARY CONDUCTORS

- A. Specified Under Division 26 Section 260123 "Wire and Cable."
- B. Underground: Type XHHW insulation, type USE cross-linked polyethylene, designed for direct burial but installed in raceway.

2.3 CONDUITS AND DUCT BANKS

- A. Conduits specified under Division 26 Section 260111 "Conduit."

- B. Rigid galvanized steel conduits on poles, rise up as directed. Use long sweep bends.
- C. Duct Banks: Minimum three inch concrete cover all sides. Form sides for smooth finish to minimize frost action.
- D. Concrete for Ductbanks: Specified under Division 03 Section "Cast-In-Place Concrete": Minimum 3000 psi concrete with one-inch maximum aggregate.
- E. Trenching, Backfill, Earthwork: Specified under Division 31 and 32.
- F. Separators: High impact polystyrene, spaced not to exceed 5'-0". Stagger the joints of the conduits by rows and layers.
- G. See Drawings for details.

2.4 OTHER MATERIALS

- A. Concrete Pad for Transformer: Specified under Division 03 Section "Cast-In-Place Concrete". Conform to Power Company requirements and details.
- B. Transformer secondary lugs and spades to accept service conductors. Verify size and coordinate with Power Co.
- C. Bonding and Grounding: Ground rods at pad, at metering, and at riser conduit at utility pole, and as required by Power Company.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Make arrangements with Power Company to obtain permanent electric service to the Project.
- B. Underground: Install service entrance conduits in concrete envelope from Power Company's pad-mounted transformer to building service entrance equipment.

3.2 PAD-MOUNTED TRANSFORMER GROUNDING

- A. Grounding: NFPA 70 and ANSI C2, and Power Company requirements, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 10 ohms. Provide multiple ground rods as required.

3.3 INSTALLATION UNDERGROUND WORK

- A. Earthwork: Excavation, backfilling, and pavement repairs for electrical requirements are specified under Divisions 31, 32, 33.

END OF SECTION 260420

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SECTION 260440 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Disconnect Switches.
- B. Fuses.
- C. Enclosures.

1.2 RELATED SECTIONS

- A. Division 26 Section 260010 "Basic Electrical Requirements."
- B. Division 26 Section 260170 "Grounding and Bonding."
- C. Division 26 Section 260180 "Equipment Wiring."
- D. Division 26 Section 260195 "Electrical Identification."
- E. Division 26 Section 260470 "Panelboards."

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 (N.E.C.) Latest Edition.
- C. U.L. Standards.
- D. ANSI Standards.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70. (N.E.C.)
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- C. Size per N.E.C. and Equipment Manufacturers' Recommendations.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures."

- B. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, horsepower, and short circuit.

1.6 SPARE PARTS

- A. Fuses: Furnish to Owner three (3) spare fuses for each circuit and each device requiring fuses. Maximum of six (6) spare fuses of each type and rating installed.
- B. Fuse Cabinet: Provided under Division 26 Section 260470 - Panelboards.
- C. Fuse Pullers: Furnish one fuse puller to Owner.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Acceptable Manufacturers:
 - 1. Cutler Hammer.
 - 2. I-T-E Siemens.
 - 3. General Electric.
 - 4. Square D.
- B. Fusible Switch Assemblies: Heavy-duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class R fuses.
- C. Nonfusible Switch Assemblies: Heavy-duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- D. Rated: Horsepower rated, 600-volt and 250-volt as required by the particular circuit with ampere rating and number of poles as indicated, or as required by the specific equipment.
- E. Enclosures: NEMA KS 1; Type 1 for interior dry locations, Type 3R raintight for exterior locations.

2.2 FUSES

- A. Acceptable Manufacturers:
 - 1. Bussman.
 - 2. Gould Shawmut.
 - 3. Littelfuse.
- B. Fuses 600 Amperes and Less: Dual element time delay current limiting Class J; 600 volt.
- C. Interrupting Rating: 200,000 RMS amperes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Section Division 26 260180 "Equipment Wiring."
- B. Install fuses in fusible disconnect switches.

END OF SECTION 260440

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SECTION 260470 – PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Panelboards.
- B. Individually mounted circuit breakers.
- C. Service panelboards.
- D. Surge Protective Devices (SPD).
- E. Metering and reporting of gas and electric usage.

1.2 RELATED SECTIONS

- A. Division 01 Section "Submittal Procedures."
- B. Division 06 Section "Rough Carpentry."
- C. Division 09 Section "Painting."
- D. Division 26 Section 260010: Basic Electrical Requirements.
- E. Division 26 Section 260170: Grounding and Bonding.
- F. Division 26 Section 260425: Switchboards.

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 N.E.C. Latest Edition.
- C. U.L. Standards.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70 (N.E.C.).
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- C. NFPA 70E Requirements from manufacturer
 - 1. Include Short Circuit and Coordination study. Coordinate pad mounted transformers with the utility.
 - 2. Based on the available short circuit and the fault clearing time, the distribution system

- components, shall limit the incident energy such that the PPE Hazard/Risk Category is 1.
- 3. Select distribution system components as required to meet this criteria.
- 4. Provide Hazard Warning Label on equipment.
- 5. See also Article "SUBMITTALS"

D. Surge Protective Device (SPD) minimum standards: IEEE C62.41& IEEE C62.45, NEMA LS 1, UL 1449 third edition or current edition, UL 1283, NEC 285. The SPD shall be installed on the load side of an overcurrent protective device unless provided with integral overcurrent protection. IEEE C62.41 Category C for main service locations, Category B for distribution and branch panel locations, and Category A when mounted at the load. The peak single-impulse ratings for SPD shall be 300KA per phase for Category C location (UL1449 Type 1 or 2), 160KA per phase for Category B location (UL1449 Type 2), and 100KA per phase for Category A location (UL1449 Type 3). Provide Surge Protective Devices located in Service Entrance panelboard.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owners' Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures."
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement, catalog, specification and sizes, panel dimensions, and gutter space.
- C. Include coordination study with recommended breaker settings and fault current and arc flash hazard analysis showing compliance for the AIC requirements.
- D. Include calculations and details of selected components to confirm compliance with the NFPA 70E criteria. Provide completed labels with following details.
 - 1. Include Completed Hazard Warning Labels To Read As Follows:
 - ! Warning; Arc Flash and Shock Hazard.
 - Appropriate PPE Required.
 - Failure To Comply Can Result In Death or Injury.
 - Refer to NFPA 70E.
 - Flash Hazard Boundary: ____inch;
 - Flash Hazard at 18 in. : ____Cal/cm²
 - Category ____; PPE Description _____.
 - Clove Class: ____.
 - Voltage: Shock Hazard when cover is removed.
 - Limited Approach: ____inch.
 - Restricted Approach: ____inch.
 - Prohibited Approach: ____inch.
 - 2. Located on each panel per NEC Art. 110.16

1.6 SPARE PARTS

- A. Keys: Furnish to Owner 1 key for each panel. All panels shall be keyed alike or to Owners keying system. Minimum 5 keys.
- B. Fuses: Furnish to Owner three (3) spare fuses for each circuit and each device specified with fuses. Maximum of six (6) spare fuses of each type and rating installed.

- C. Fuse Pullers: Furnish one fuse puller to Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES - PANELBOARDS

- A. Eaton/Cutler-Hammer.
- B. I-T-E Siemens.
- C. General Electric.
- D. Square D.

2.2 PANELBOARDS RATED 400AMPERE AND LESS

- A. Circuit breaker type with mains and circuits as indicated on the Drawings and all designed for three phase, four wire, solid neutral, 60 cycle service rated for 120/208 volt service as scheduled.
- B. Enclosure: NEMA Type 1 except as noted. Code gauge galvanized steel boxes and enameled steel fronts, with door-in-door trim, sized for 6" minimum side, top and bottom gutters, or greater as required by NEC. Flush or surface mounting as indicated by the panel schedule, concealed hinge and flush lock all keyed alike.
- C. Bus: Copper ratings as scheduled on Drawings. Provide sub-feed and feed-through lugs as required. Lugs designed for use for both copper and aluminum conductors. Sub-feed shall signify that lugs are tapped ahead of buses and feed-through shall signify that lugs are tapped on load side of the main and buses.
- D. Neutral Bar: Copper, full size insulated from the cabinet and provided with lugs for each branch circuit space in the panel.
- E. Bonding strap securely attached to the cabinet with lugs as required to receive the bonding conductors indicated and specified.
- F. Minimum Integrated Short Circuit Ratings as in dictated on panelboard schedules.
- G. Molded Case Circuit Breakers: Toggle type thermal-magnetic, quick-make, quick-break, with silver-plated contacts, bolt-in type, and with common trip for multiple circuits. Breakers shall have a nominal thickness of 1" per pole. Provide circuit breakers UL listed as Type SWD for switching lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where indicated.

2.3 INDIVIDUALLY MOUNTED CIRCUIT BREAKERS

- A. Circuit Breakers as Main: As specified above for Main Panelboard: U.L. labeled for use as service entrance equipment.
- B. Molded Case Circuit Breakers: As specified above for Panelboards.

- C. Enclosure: NEMA Type 1 general purpose except as noted.
- D. Flush or surface mounted as indicated.

2.4 ACCEPTABLE MANUFACTURERS - FUSES

- A. Buss or equal.

2.5 FUSES

- A. See Section 260440.

2.6 INTEGRAL OR EXTERNALLY MOUNTED SPD

A. ACCEPTABLE MANUFACTURERS

1. Current Technology.
2. Panel board manufacturer.

- B. Provide SPD either integral to panelboards in an isolated compartment, a panelboard enclosure extension or external to the panelboard with the shortest conductor lengths possible for any of the above points of installation. Five feet or less length of phase conductor, neutral and ground conductors is desired) If longer wire length is required install SPD with low impedance high performance interconnect (HPI) cable. SPD Vendor shall supply the HPI cable. Installer must inform SPD manufacturer of HPI cable lead length needed but length shall not exceed 30'.

- C. Rated voltage designed for panel served: 120/208 VAC 3 phase, 4 wire plus ground.

- D. Suppression Response: ANSI/IEEE C62.41 Category A & B & C for locations served.

- E. Voltage Protective Rating (VPR) shall be stated and marked on SPD.

- F. UL Standard 1449 3rd Edition or current edition with Type Category shall be marked on the SPD.

- G. EMI/RFI Noise Filtering: Provide with noise filter per UL-1283, mark UL-1283 compliance on SPD.

- H. UL1449 Nominal Discharge Surge Current Rating (I-n) shall be 20KA at main service, distribution and branch panel locations. Point of use locations may be 10KA. The Nominal Discharge Surge Current Rating shall be on the nameplate of the SPD.

- I. The SPD shall be a seven (7) mode device: 3 x L-N, 3 x L-G, and N-G.

- J. Main Panels rated 400 Amperes and over: Design performance basis Current Technology TG3 Series or equivalent.

1. Max Surge Current per phase/per mode: 300KA/150KA
2. Internal suppression module or modules must be replaceable at Main Service locations (modular construction).
3. UL1283 electrical noise filter.
4. Internal combination thermal and surge rated fusing. 200KAIC.
5. Audible alarm.

6. Alarm re-set feature.
7. Digital Surge Counter.
 - a. LED Phase Status indication:
 - 1) Green > 75% protection.
 - 2) Orange 40-75% protection.
 - 3) Red < 40% protection.
 - b. Orange or Red led status shall be the basis for warranty claim.
8. Dry Contacts for remote monitoring.
9. The SPD shall be connected to a minimum 100A circuit breaker in the main panel.
10. NEMA 4 or 12 Enclosure.
11. Safety Barrier over electrical connections.
12. 15 year SPD Mfg. warranty.

2.7 METERING

- A. Provide self-contained metering at gas and electrical services capable of reporting whole building metering in one hour intervals. Electrical meter shall measure voltage and amperage.
- B. Provide WEB based user interface with the following minimum capabilities:
 1. Display energy usage for current day, previous day, same day of previous year, monthly data and cumulative energy usage for previous 12 months.
 2. Storage capacity of no less than 36 months. Stored data shall be accessible by the user.
 3. Savable/Printable quarterly summary report showing energy consumption for that quarter.
- C. Load and gain access to interface on owner designated PC.
- D. Present screens to owner for review and make adjustments as directed by owner for their ease of use.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards plumb and properly secured. Recessed panels shall be flush with wall finishes.
- B. Height: Per N.E.C or as specifically indicated.
- C. Provide filler plates for unused spaces in panelboards.
- D. Provide typed directory completely filled-in indicating outlets, fixtures, devices, and locations served by the circuit. Revise directory to reflect circuiting changes required to balance phase loads.
- E. Stub 4 empty one inch conduits to accessible location above, ceiling and below floor, from each recessed panelboard that has accessible ceilings above and/or below the panel.
- F. Provide completed Hazard Warning Labels mounted on each panel.
- G. Finish painting of flush panelboards and individually mounted breakers shall be as specified in Division 09 Section "Painting".

- H. Properly support backboards, and panels. Coordinate with Division 06 Section "Rough Carpentry", to provide blocking as required.
- I. Properly support backboards, and panels. At non structural walls, provide separate support system for panelboards and equipment. Use UNISTRUT P5000 channels or equal. Length and spacing to form rigid separate wall. In other areas, coordinate with Division 06 Section "Rough Carpentry", to provide blocking as required.

3.2 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

3.3 WARNING

- A. Provide Label on exterior of all panels served by the generator: "Warning Panel is Served by Two Sources (Emergency & Normal). Both Sources Shall Be Locked OFF Before Servicing."

3.4 PANELBOARD SCHEDULES

- A. See Drawings.

3.5 TRAINING

- A. Provide user training on metering system user interface. Minimum one four hour onsite hands-on training.

END OF SECTION 260470

SECTION 260510 – LUMINAIRES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior and exterior luminaires and accessories.
- B. Exterior luminaires, poles, bollards and accessories.
- C. Additional wiring methods for luminaires.

1.2 RELATED SECTIONS

- A. Division 26 Section 260010: Basic Electrical Requirements.
- B. Division 26 Section 260111: Conduit.
- C. Division 26 Section 260123: Wire and Cable.
- D. Division 26 Section 260130: Boxes.
- E. Division 26 Section 260170: Grounding and Bonding.
- F. Division 26 Section 260141: Wiring Devices. (for self contained local controls)
- G. Division 26 Section 260149: Lighting Control System. (for network controlled Lighting)

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 N.E.C. Latest Edition.
- C. U.L. Standards.
- D. ANSI/NFPA 101 - Life Safety Code.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70 (N.E.C.).
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- C. Luminaire and pole sized for minimum 100 m.p.h. steady wind with 1.3 gust factor.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".
- B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- C. Product Data: Provide dimensions, ratings, performance data and total input watts.
- D. Include point to point computer modeling on scaled site plans, showing initial footcandle levels for exterior site lighting in a 10 to 10 foot grid, at ground level. Submittals shall show a matrix of footcandle numbers. Calculations shall include all pole-mounted and building-mounted fixtures. Submittals for substituted lighting will not be reviewed without these calculations and recommendations.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site. Inspect for damage.
- B. Protect from moisture, corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.7 PROJECT CONDITIONS

- A. Wiring to fixtures as shown on Drawings is diagrammatic only and is intended to show circuit and switching arrangements. Fixtures shall not be used as raceways except as specifically allowed by N.E.C. Art 410.
- B. Where panel designation and circuit numbers are shown with no homerun symbol, wiring to same circuits may share same homerun to panel. See voltage drop and distance restrictions in Division 26 Section 260010.

PART 2 - PRODUCTS

2.1 LUMINAIRES

- A. Furnish products as specified in schedule on Drawings.
- B. Refer to Lighting Fixture Schedule General Notes for requirements regarding Design Lights Consortium (DLC) and Energy Star listings.
- C. All fixtures shall be approved by Underwriters' Laboratories, Inc., and bear Underwriters' labels.
- D. In addition to the manufacturers listed on the Drawings, fixtures with equivalent details and matching characteristics as provided by manufacturers listed below shall be considered for approval after review of Shop Drawings.

- E. Poles: Provide poles with each site/roadway luminaire. Height, round, square, aluminum or enamel steel as indicated on the schedule. Color to match luminaire. Handhole capable of accepting a duplex receptacle.
- F. LED Dimming Driver:
 - 1. Equal to Advance Xitanium (0-10V).
 - 2. Fully electronic designed to operate properly on the LED sources indicated. Coordinate with LED manufacturer for compatibility.
 - 3. Drivers shall have a Class A sound rating.
 - 4. Dimming shall be controlled by a Class 1 or Class 2 low-voltage 0-10V circuit.
 - 5. Driver shall operate LEDs at a frequency of 60 Hz.
 - 6. Drivers shall operate from 50/60 Hz input source of 120V or 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the drive..
 - 7. Driver shall have a Power Factor greater than 90% and the input current shall have Total Harmonic Distortion (THD) of less than 20%.
 - 8. Driver shall tolerate sustained open circuit and short circuit output conditions without damage and without need for external fuses or trip devices.
 - 9. Driver shall have a minimum operating temperature of -40C (-40F).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Complete with wiring, drivers, stems, hangers, fittings, end plates, pendant feeds, aircraft cable, etc...
- B. Install in accordance with manufacturer's instructions.
- C. Suspended Luminaires.
 - 1. Pendants:
 - a. 1/2" rigid conduit stems, painted to match fixture, with swivel mounts.
 - b. Provide pendant length required to suspend luminaire at indicated height. Cut or lengthened to give mounting heights as indicated and required.
 - 2. Air-Craft Cable:
 - a. Where indicated provide aircraft cable suspension. Feed end shall have canopy with feed grommet and white coiled cord wrapped around cable. Stretch coil making 1" gaps.
 - b. Provide cable length required to suspend luminaire at indicated height. Cut or lengthened to give mounting heights as indicated and required.
 - 3. Chain Hung:
 - a. Where fixtures are specifically indicated to be chain mounted, provide wire hook chain set & jack chains cut to length as required to suspend luminaire at indicated height. Use MC cable supported by cable ties from fixture to junction box mounted in structure above each fixture.
 - 4. Except as specifically noted, all fixtures shall be supported from structural steel. Provide unistrut channels or equal to span between top cord of joists. Supports shall be suitable for fixture weight and seismic forces.
 - 5. Suspension details shall be submitted for approval prior to installation.

- D. Provide 12 gauge safety hanger wire supports for all fixtures recessed in ceiling grids of suspended acoustical ceilings. Hangers shall be independent of ceiling framing suspension system and shall extend from fixture housing to structure above. Lighting fixtures weighing less than 56 pounds shall have two hangers, at diagonal corners of fixture (2 locations). Lighting fixtures weighing more than 56 pounds shall have four hangers, one at each corner of fixture (4 locations). Wires shall have no tension (slack) to prevent ceiling distortion. In addition, attach to ceiling framing "T"s as required by code.
- E. Fixtures with one (1) piece 8' channel shall be supported within two feet (2') of each end and fixtures with 4' channel shall be supported within one foot (1') of each end. Fixtures indicated in continuous rows shall have ends bolted together and shall be provided with 4' long lens constructed so the joint between two (2) sections of an 8' fixture appear the same as two (2) 4' fixtures butted together.
- F. Fixtures in sloping ceilings shall have angle face plate for proper orientation of fixture.
- G. Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Fixtures shall have frame and trim details to match the ceiling suspension system furnished. Coordinate details with Acoustical Treatment Section and installation with the Ceiling Installer to assure fixtures are centered on tiles or on joints as required.
- H. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Install spacers where required to allow proper installation of rabbeted (Tegular) ceiling tiles. Secure to prevent movement.
- I. Install clips to secure recessed luminaires in place. Install recessed luminaires to permit removal from below.
- J. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- K. Install wall mounted luminaires at height as indicated.
- L. Install accessories furnished with each luminaire.
- M. Additional Wiring Methods For Luminaires:
 - 1. Refer to Division 26 Section 260010 - Basic Electrical Requirements: Performance Requirements.
 - 2. Refer to Division 26 Section 260123 - Wire and Cable: Wiring Methods.
 - 3. Recessed and surface incandescent fixtures: Wiring rated minimum 300°F in metallic conduit where required for Underwriters' approval.
 - 4. Fluorescent Fixtures: Wiring within housings and between fixtures and junction boxes above ceilings shall be Type THHN insulated conductors rated for use at temperatures not lower than 90°C.
 - 5. Wiring from recessed fixtures to junction boxes: As described in Division 26 Section 260010 "Basic Electrical Requirements": Performance Requirements.
 - 6. Wiring to exterior pole mounted luminaires and bollards: Per Division 26 Section 260111 "Conduit": Conduit Requirements for underground installations and Section 260123 "Wire and Cable": Wiring Methods for underground installations and as shown on the Drawings.
- N. Bond products and metal accessories to branch circuit equipment grounding conductor.

- O. Install specified lamps in each luminaire.
- P. Install poles and bollards plumb. Provide shims or double nuts to adjust plumb. Grout around each base for neat smooth tight finish.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. In areas with no ceilings locate fixtures to avoid interference with mechanical and structural features.
- B. In finished spaces, consult the Architect prior to making adjustment to fixture locations.

3.3 FIELD QUALITY CONTROL

- A. All fixtures and equipment shall be in first-class condition at time of delivery of building to Owners with all scratches, mars, etc., refinished to factory standards.
- B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.4 ADJUSTING/CLEANING

- A. Aim and adjust luminaires after dark as directed.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosure.
- D. Clean photometric control surfaces using procedures as recommended by manufacturer.
- E. Clean finishes and touch up damage.

3.5 SCHEDULE

- A. Shown on Drawings.

END OF SECTION 260510

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SECTION 260535 – EMERGENCY LIGHTING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Emergency lighting battery units.
- B. Exit signs.

1.2 RELATED WORK

- A. Division 26 Section 260010 “Basic Electrical Requirements.”
- B. Division 26 Section 260111 “Conduit.”
- C. Division 26 Section 260123 “Wire and Cable.”
- D. Division 26 Section 260130 “Boxes.”
- E. Division 26 Section 260170 “Grounding and Bonding.”
- F. Division 26 Section 260510 “Luminaires.”

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 (N.E.C.) Latest Edition.
- C. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
- D. U.L. Standards.
- E. ANSI Standards.

1.4 DESIGN REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.(N.E.C.)
- B. Conform to local and state building codes and NFPA 101 for installation requirements.
- C. Furnish products listed and classified by Underwriters Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- D. All components of the same manufacturer.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures."
- B. Include all components, electrical characteristics, recommended maintenance procedures and intervals, [current prices of replacement parts and supplies], [list of each battery unit and the total device count and load on each unit].
- C. Submit manufacturer's instructions.

1.6 WARRANTY

- A. Fully guaranteed for a minimum of three (3) years.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Lithonia.
- B. Lightalarms.
- C. Sure-Lites.
- D. Chloride.
- E. Dual-Lite.
- F. Prescolite.

2.2 EMERGENCY LIGHTING BATTERY UNITS

- A. Ceiling Mounted
 - 1. Chloride – C4-2-25L-W-2-M7F-IC-T: 12 volt, 7 watt LED MR16 lamps, 12GA steel trim plate with powder coat finish, sealed lead calcium battery with Self-Testing Diagnostics, provide Damp Location Listing where indicated.
- B. Unit Voltage: Universal

2.3 RECESSED RETRACTABLE EMERGENCY LIGHTING "CONCEALITE" BATTERY UNITS

- A. Compact self-contained, fully automatic operation with 12 volt, D.C. motor operated door. Complete with: fully recessed cabinet, sealed maintenance free nickel-cadmium battery, automatic solid state or two-pole type transfer relay, integral test switch, and charge indicator.
- B. Batteries: Sufficient capacity to supply and maintain at not less than 87-1/2 percent of system voltage the total lamp load indicated for a period of time as required by latest edition of NEC,

(90 minutes minimum). Initially oversize to meet this criteria over battery's entire life.

- C. Unit Voltage: Universal 120/277 volts, AC.
- D. Unit Mounted Heads: two, 3 watt LED lamps 30 degree distribution.
- E. Manufacturer: Concealite 5000 Series, model # F5-LED30-90-FMS-NC, paintable surface. Paint to match surroundings.

2.4 AUTOMATIC INVERTER EMERGENCY POWER SYSTEM

- A. Heavy duty steel (NEMA-1) cabinet with white powder coat finish, surface and ceiling grid mounting options with multiple conduit entries.
- B. Complies with UL-924, NFPA-101, NEC, IBC, BOCA and OSHA illumination standards.
- C. Shall operate incandescent, fluorescent, and LED lighting loads and be compatible with dimming drivers and ballast. Verify LED loads and associated in-rush current characteristics and size output fusing accordingly.
- D. Electrical:
 - 1. 100VA Recessed Ceiling Mount, 120/277V, 0.503/0.224
 - 2. 250VA Wall Mount, 120/277V, 0.542/0.253A.
- E. Electronics:
 - 1. Solid state PWM inverter with sine wave output.
 - 2. Frequency 60Hz +/- 2Hz.
 - 3. Load power factor capability of 0.5 lagging to 0.9 leading.
 - 4. Universal 120/277 VAC input and output.
 - 5. Normally ON or OFF loads.
 - 6. Brownout protection is 75% of normal line voltage.
 - 7. Low voltage disconnect (LVD).
 - 8. DC overload and short circuit protection.
 - 9. Battery cycling test/diagnostics.
- F. Electronics Charger:
 - 1. Temperature compensated 24V linear charger.
 - 2. DC battery fuse.
 - 3. 72 hour battery recharge time.
- G. Indicators/Controls:
 - 1. Lighting Loads fuses.
 - 2. DC battery fuse.
 - 3. Battery cycling test/diagnostic status indicators:
 - a. Green normal AC power ON.
 - b. Yellow emergency mode.
 - c. Amber battery cycling test indicator.
 - d. Red battery fault.
- H. Battery:

1. Maintenance free. Sealed lead calcium battery with an expected life up to six (6) years, and optimum operating range of 68°F (20°C) to 86°F (30°C).
2. Minimum 90 minutes of battery operating time.

I. Warranty:

1. Unit/Electronics: 5 years full.
2. Battery: 3 years full, 7 years pro-rata.

J. Philips Chloride – ZI-T/S-100/250-AD-ZIRT.

2.5 EXIT SIGNS

A. LED Exit Sign:

1. Chloride – ER46L-1/2-R: Flat black with brushed aluminum face, universal LED type Self-powered, complete with ceiling, side wall brackets, red letters, arrows and faces as indicated. Brown out, low voltage disconnect, test switch, power indicator and self-diagnostics.

B. Edge-Lit LED Exit Sign:

1. Chloride – ER44RLDU-1/2-R: Extruded aluminum housing and trim plate, universal LED type Self-powered, wall or ceiling mounting, red letters, arrows and faces as indicated. Brown out, low voltage disconnect, test switch, power indicator and self-diagnostics.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units plumb and level.
- B. Aim directional lamp heads to maximize light in egress paths and as directed.
- C. D.C. Wiring: No.10 AWG. minimum, or as noted, in rigid conduit or electrical metallic tubing or concealed MC cable.
 1. Except as noted, use home run from each device to associated battery unit.
 2. Devices may share same home run to battery unit provided that each home run meets the following criteria or wire sizes are increased to assure maximum of 2-1/2% voltage drop.

Total Watts	Total Conductor Distance
70	25 ft.
50	35 ft.
36	45 ft.
19	95 ft.
- D. AC Wiring to Exit Lights: In separate conduit, or MC cable with ground.
- E. Exit Sign Mounting: Generally mount directly above and centered over the doorway opening, on the wall where possible, or mounted from the ceiling when wall mounting is not possible. End wall mounted where required, up 8'-0" AFF, coordinate with architectural interior elevations. The intent is to locate signs to allow for maximum visibility. Consult Architect before installation, if in question.

END OF SECTION 260535

SECTION 260721 – FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Complete Addressable Voice Evacuation Fire Alarm System including but not limited to:
 - 1. Equipment, materials, labor, installation, connection, programming, testing, training and performance of all operations of the intelligent reporting fire alarm system as indicated on the drawings and as herein specified.
 - 2. Alarm initiating devices, alarm notification appliances, fire alarm control panel (FACP), auxiliary control devices, annunciators, and wiring.
 - 3. Reporting of alarm to Portland Fire Department via Master Box.

1.2 RELATED SECTIONS

- A. Division 08 Section “Door Hardware”.
- B. Division 26 Section 260010 “Basic Electrical Requirements”.
- C. Division 26 Section 260195 “Electrical Identification”.

1.3 REFERENCES

- A. NFPA 70 (N.E.C.) latest edition.
- B. U.L. Standards.
- C. FM Factory Mutual
- D. NFPA 72 National Fire Alarm Code.
- E. ADA - Americans with Disabilities Act.
- F. NFPA 101 - Life Safety Code.
- G. Local and State Codes.
- H. Local Fire Department - Rules & Regulations for the Installation of Fire Alarm Systems.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of NFPA 70. (N.E.C.), specifically Art 760.
- B. Conform to requirements of the National Fire Protection Association, Standards NFPA 72, NFPA 101 and also all applicable Federal, State and Local Codes (City of Portland Code of Ordinances Chapter 10, Fire Prevention and Protection).

- C. All requirements of the Authority Having Jurisdiction (AHJ).
- D. All components of the same manufacturer, FM approved and listed by Underwriters' Laboratories, Inc., and so labeled.
- E. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown. The fire alarm control panel, network interface and all transponders shall meet the modular labeling requirements of U.L. Each subassembly, including all printed circuits, shall include U.L. modular labels.
- F. Include all necessary software, programming and the selection of the proper type and quantities of the system components to assure a complete, operational, and Code Compliant System.
- G. System shall be completely field programmable.
 - 1. Provide the Owner with all required components, interfaces and passwords to allow them full access to the programming features. Provide minimum of 8 hours on site training on programming features.
 - 2. Provide all hardware, software, programming tools, and documentation necessary to allow modifying the fire alarm network on site. Modifications include addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices and zones.
 - 3. The system structure and software shall place no limit on the type and extent of ON-SITE software modifications. Software modification shall not require power shut down of system and shall not cause loss of system fire protection while making modifications.
- H. Special Programmable Features:
 - 1. HVAC units: Interface shall be field programmable to allow activation on general alarm and/or on selective zoning of local detectors. Set initially to shut down on general alarm, plus send status signal to the Energy Management/Temperature Control system (ATC) provided under Division 23 Section "Instrumentation and Control for Mechanical Systems". For all HVAC equipment that is required to be shut down upon a fire alarm condition, ensure that fire alarm shutdown of equipment is wired through input contacts within the starter enclosure. Upon receipt of a signal from the building's fire alarm system, power to the load side of the starter shall be turned off. Circuitry shall be provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, Division 23 shall be responsible for providing a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements specified under this division.
 - 2. HVAC Duct Smoke Dampers: Interface shall be field programmable to allow activation on general alarm and/or on selective zoning of local detectors. Set initially to close dampers on general alarm, plus send status signal to the Energy Management/Temperature Control system (ATC) provided under Division 23 Section "Instrumentation and Control for Mechanical Systems".
 - 3. Smoke doors: Interface shall be field programmable to allow activation on general alarm and/or on selective zoning of local detectors. Set initially as general alarm with output interface relay connected to close the doors.
- I. The drawings do not show all details of the Fire Alarm System. It shall be the responsibility of the authorized supplier/installer to provide a fully operational code compliant system.

- J. Coordinate with and obtain approval from the local Fire Chief (AHJ), prior to the Shop Drawing submittal. See Item Submittals.

1.5 SYSTEM DESCRIPTION

- A. Fire Alarm System: Addressable automatic and manual initiating, Intelligent reporting, microprocessor controlled fire detection and emergency voice fire alarm system with network communications capabilities.
- B. An active/interactive type system where each FACP is repetitively scanned, causing a signal to be transmitted to the local fire alarm control panel node indicating that the FACP and its associated initiating devices and notification appliance circuit wiring is functional. Loss of this signal at the local FACP shall result in a trouble indication on both the FACP display and at the network display.
- C. Emergency Voice Alarm Communication System: In areas of “Places of Assembly” (entire building), a digitized recorded voice message shall notify occupants that a fire condition has been reported. The message shall inform the occupants with emergency instructions. Emergency manual override shall allow instruction from the fire fighter’s microphone.
- D. System shall have a student recall signal. Signal shall be separate and distinct from any other signals used in the facility. Initiating button shall be under key lock as required by NFPA 101. Whether shown on the Drawing or not, provide exterior recall signals. One signal at each exterior door, minimum of four signals, one per building side. Obtain approval for locations prior to installation.
- E. System Performance and Supervision:
 - 1. Alarm, trouble and supervisory signals from all intelligent reporting devices: Encoded on NFPA style 4 (Class B) signaling line circuits (SLC).
 - 2. Initiating device circuits (IDC): Wired class A NFPA Style D as part of an addressable device connected by the SCL circuit (end of line returns to the panel using a separate path).
 - 3. Notification appliance circuits (NAC): Wired class B NFPA Style Y.
 - 4. Digital electronic signals: Employ check digits or multiple polling.
 - 5. Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode.
 - 6. Occurrence of single ground or open condition in the initiating circuit does not disable any device on that circuit.
 - 7. Occurrence of single ground or open condition on alarm initiating or signaling circuits does not disable that circuit from transmitting in ALARM.
 - 8. Component or power supply failure places system in TROUBLE mode.
 - 9. Alarm signals arriving at the main FACP shall not be lost following a primary power failure until the alarm signal is processed and recorded.
 - 10. Batteries: Under or over battery voltage, shorted or disconnected battery supply places system in TROUBLE mode.
 - 11. FACP devices are to consist of low current, solid-state integrated circuits, and shall be powered locally from a primary power and standby power source.
 - 12. Power for initiating devices and notification appliances must be from the main fire alarm control panel, the FACP to which they are connected or to a Field Charging Power Supply (FCPS).
 - 13. Notification appliance circuits shall have 25% spare capacity.
 - 14. Where speakers are used:

- a. Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per smoke zone.
 - b. Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.
 - c. Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Amplifiers shall be located in FACP cabinets.
 - d. Speaker circuits shall be 25 VRMS. Speaker circuits shall have 25% space capacity for future expansion or increased power output requirements.
 - e. A prerecorded voice module shall be used to store tones and/or messages and transmit them over speaker circuits automatically upon alarm actuation. The voice module shall have reliable, non moving parts.
 - f. Speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.
- F. Alarm Sequence of Operation: Actuation of manual fire alarm station, automatic initiating device and sprinkler flow switches causes system to enter ALARM, which includes the following operations:
- 1. Disable the sound systems. Provide interfacing relays as required to assure that local programs will not obscure the fire alarm audible devices. Coordinate with the successful sound system vendor to assure proper operation. Provide relays with separate isolated contacts at each sound system amplifier to provide a signal to power down the sound system amplifier upon activation of a fire alarm condition. Where the sound system amplifier does not support remote shutdown of the amplifier provide a contactor (min 20 ampere rated) to interrupt the power feed to the sound system amplifier.
 - 2. Indicate location of alarm zone on fire alarm control panels for all events.
 - 3. Indicate on FACP and remote 80 character LCD display.
 - 4. Activate programmed speaker circuits and audio visual devices.
 - 5. Light the associated indicators corresponding to the active speaker circuit.
 - 6. Transmit signals to the fire department.
 - 7. De-energize 120 volt magnetic door holdbacks. Holdbacks provided under Division 08 Section "Finish Hardware".
 - 8. Activate all programmed events.
 - 9. Sound and display throughout the building the fire alarm signaling devices and the pre-recorded messages as required evacuating all areas of the building.
 - 10. See Special Programmable Features for additional requirements.
- G. Alarm Silence: The alarm horns may be silenced, after three (3) minutes, at the associated locked control cabinet. Alarm lights shall remain flashing until system is reset. A subsequent zone alarm shall reactivate the signals.
- H. Alarm Reset: RESET function resets alarm system to NORMAL condition (out of ALARM) if alarm initiating circuits have cleared.
- I. Trouble Sequence of Operation: System trouble, including grounding or open circuit of supervised circuits, or power or system failure causes system to enter TROUBLE mode, including the following operations:
- 1. Visual and audible trouble alarm by zone at associated control panel.
 - 2. Visual and audible trouble alarm at annunciator panels.

3. Manual ACKNOWLEDGE function (trouble silence switch) at control panel silences audible trouble alarm; visual alarm is displayed until initiating trouble is cleared.
- J. The activation of any system smoke detector shall initiate an Alarm Verification operation whereby the panel resets the activated detector and waits for a second activation. If, after reset, a second alarm is reported from the same or any other smoke detector within one (1) minute the system shall process the alarm. If no second alarm occurs within one minute the system shall resume normal operations. The Alarm Verification shall operate only for smoke detectors. Other activated initiating devices shall be processed immediately.
 - K. Zoning: Programmable, initially set up as scheduled on Drawings. Provide labor to reschedule zones as direct by owner and Fire Department.

1.6 QUALIFICATIONS

- A. Fire alarm equipment Manufacturer:
 1. Company specializing in manufacturing the products specified in this Section with minimum five years documented experience.
 2. Company maintaining engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.
- B. Supplier/Installer (Vendor):
 1. Company authorized by the manufacturer and specializing in fire alarm systems with minimum five years experience.
 2. Company shall employ NICET (minimum Level II fire alarm technology) technicians.
 3. Company offering service contracts for continuing factory authorized service after the initial warranty period.

1.7 SUBMITTALS

- A. Prior to submitting Shop Drawings to the Architect/Engineer, set up a meeting at the Local Fire Department with a complete submittal package. Meeting shall include the Fire Chief, Assistant Fire Chief, and, System Vendor. Vendor shall present the proposed system to the Fire Department and describe in detail, the operation. Once the fire department is satisfied that the proposed system satisfies their requirement (including locations of ADA required Strobes), then the shop drawings may be submitted to the Architect/Engineer along with a copy of the minutes of the meeting. Shop drawings will not be reviewed by the Architect/Engineer without this presentation and minutes of the meeting. Graphic annunciator panel detail plan and drawing shall be submitted to the Local Fire Department for approval before installation.
- B. Include floor plans showing all devices, wiring, and connections: Plan layout, connection diagrams and catalog cuts of all components. Use 1" = 20' composite contract drawing for shop drawing purposes and shall be marked-up showing all wiring between devices, number of conductors, and labeling system. Shop drawings will not be reviewed by the Architect/Engineer without these drawings.
- C. Include proposed wiring color code and verification that it meets local fire department standards.
- D. Include narrative description of system functions and sequence of operation.

- E. Include catalog cuts of all equipment, devices, annunciator layout, control panel modules, and internal terminal configurations.
- F. Include documentation showing proof of U.L. listing for all system components.
- G. Include System Power Supply Requirements:
 1. Total panel supervisory current.
 2. Total horn/light signal current.
 3. Total auxiliary power.
 4. Total smoke detector supervisory and alarm power.
 5. Total battery amp-hour calculations.
 6. Total power on each Field Charger/Power Supply (FCPS).
 7. Voltage drop on each notification circuit (voltage drop at each appliance).
- H. Include all cable types.
- I. Include letter verifying that system has been reviewed and approved by the local Fire Department.
- J. Include second year extended service contract listing services included and costs. The cost of this service contract is included under this section.
- K. Submit manufacturer's instructions.

1.8 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations and mounting heights of outlets if not as shown on Drawings, plus pull and junction boxes larger than 12x12x6 inches.
- B. Accurately record actual routing of conduits larger than 1 inch and main wiring trunks.

1.9 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- C. Include operating instructions, and maintenance and repair procedures.
- D. Include manufacturer's representative's letter stating that system has been tested and is operational. Use NFPA 72 FIRE ALARM SYSTEM CERTIFICATION and DESCRIPTION form.

1.10 EXTRA MATERIALS

- A. Provide two manual pull stations.
- B. Provide two keys of each type.
- C. Provide one smoke detector of each type.

- D. Provide one heat detector of each type.
- E. Provide one horn/light and one speaker/light and one adjustable Cd strobe.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Notifier: Addressable system. Model numbers used except as noted.
 - 1. Gamewell.
 - 2. Simplex.
 - 3. Edwards
 - 4. Siemens

2.2 FIRE ALARM CONTROL PANELS AND COMMAND CENTER

- A. Provide all necessary modules for a complete operational system as specified herein. Panel shall include a microprocessor based central processing unit (CPU). The FACP shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, transponders, local and remote operator terminals, printers, annunciators, emergency voice communication systems, and other system controlled devices. All panel locks shall accept Gamewell, Simplex or FCI key.
- B. FACP shall perform the following functions:
 - 1. Supervise and monitor all intelligent/addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 - 2. Supervise all signaling and notification circuits throughout the facility.
 - 3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.
 - 4. Visually and audibly annunciate any trouble, supervisory or alarm, condition on operator's terminal, panel display, and annunciators.
- C. Capacity and General Operation:
 - 1. Each loop capable of expansion to 318 intelligent addressable devices. System capable of 10 loops. Provide number of loops as required to support the system indicated with a minimum of four loops. Provide expansion to be able to add an additional two loops.
 - 2. FACP shall include a full featured operator interface control and annunciation panel which shall include a backlit Liquid Crystal Display (LCD), individual, color coded system status LED's and an alpha-numeric keypad for field programming and control of the fire alarm system.
 - 3. The system shall include emergency voice communications utilizing distributed amplification and intelligence such that loss of operation by the main FACP will not result in the loss of evacuation signal throughout the balance of the building.
 - 4. FACP shall provide the following features:

Block Acknowledge	Printer Interface
Charger rate control	CRT Display Interference
Control-by-time	Non-Alarm Module Reporting
Day/Night Sensitivity	Periodic Detector Test
Device Blink Control	Remote Page

Drift Compensation	Trouble Reminder
NFPA 72, Sensitivity Test Upload/Download to PC Computer	
System Status Reports	Verification Counters
Security Monitor Points	Walk Test
Alarm Verification	Maintenance Alert

D. Central Processing Unit (CPU):

1. FACP shall include a central processing unit. The CPU shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the CPU.
2. Each CPU shall contain and execute all control-by-event interlock for specific local and network action to be taken if an alarm condition is detected by the system. Control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3. The central processing unit shall also provide a real-time clock for time annotation of all system displays. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.

E. Signaling Line Circuits (SLC):

1. The system shall include four SLC circuit. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a system capacity of 318 devices. Each SLC loop shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring. The system shall have the space and capacity to add an additional two SLC circuits.
2. The Loop Interface Board (LIB) shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
3. The detector software shall meet NFPA 72, requirements and be certified by UL as a calibrated sensitivity test instrument.
4. The detector software shall allow manual or automatic sensitivity adjustment.

F. Serial Interfaces:

1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Electronic Data Processing (EDP) peripherals.
2. The system shall include an EIA-485 port for the serial connection of annunciators and remote LCD displays.
3. The EIA-485 interface may be used for network connection to a proprietary receiving unit.

G. Notification Appliance Circuit (NAC) Module:

1. The notification appliance circuit module shall provide four fully supervised Class A or B (NFPA Style Z or Y) notification circuits. An expansion circuit board shall allow expansion to eight circuits per module.
2. The notification circuit capacity shall be 3.0 amperes maximum per circuit and 6.0 amperes maximum per module.
3. The module shall not affect other module circuits in any way during a short circuit condition.
4. The module shall provide eight green ON/OFF LEDs and eight yellow TROUBLE LEDs.

5. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
 6. Each notification circuit shall include a custom label inserted to identify each circuit's location. Labels shall be created using a standard typewriter or word processor.
 7. The notification circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.
 8. Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.
- H. Control Relay Module:
1. The control relay module shall provide four Form-C auxiliary relay circuits rated at 5 amperes, 28 VDC. An expansion circuit board shall allow expansion to eight Form-C relays per module.
 2. Each relay circuit shall be capable of being activated (change in state) by any initiating device or from any combination of initiating devices.
 3. The expansion module shall provide 8 green ON/OFF LEDs and 8 yellow LEDs (indicates disabled status of the relay).
 4. The module shall provide a momentary switch per relay circuit that may be used to manually turn the relay ON/OFF or to disable the relay.
 5. Each relay circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or word processor.
 6. The control relay module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal blocks shall be UL listed for use with up to 12 AWG wire.
- I. Remote Relay Module: Notifier model number ACM-8R
1. Remote relay module with eight Form-C relays per module.
- J. Voice Control Module (speaker circuit module):
1. The voice control (speaker circuit) module shall provide four fully supervised Class B (NFPA Style Y) or Class A (NFPA Style Z) speaker circuits. An expansion circuit board shall allow expansion for up to eight circuits per module.
 2. Each speaker circuit shall be capable of switching up to 30 watts maximum per circuit or 60 watts per four circuit module.
 3. If a short-circuit trouble occurs on one of the circuits, that circuit will not activate on either manual or automatic command.
 4. The module shall provide green ON/OFF LEDs and yellow TROUBLE LEDs.
 5. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
 6. Each voice circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or word processor.
 7. The voice control module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL Listed for use with up to 12 AWG wire.
 8. Each speaker circuit module may be programmed to activate on activation of the All-Call switch and to deactivate upon pressing the signal silence switch.

K. Voice Command Center (VCC):

1. The Voice Command Center (VCC) shall contain all equipment required for all audio and voice control, signaling and supervisory functions. This shall include amplifiers, tone generators, digital voice units, and a microphone. The voice command center shall be an integral part of the fire alarm control panel.
 - a. Function: The VCC equipment shall perform the following functions:
 - 1) Operate as a supervised single channel emergency voice communication system.
 - 2) Audibly and visually annunciate the active or trouble condition of every speaker circuit and telephone circuit.
 - 3) Audibly and visually annunciate any trouble condition of tone generations and digital voice units required for normal operation of the system.
 - 4) Provide all-call activities per location plus all locations through activation of a single control switch. Line voice page shall be associated with the Area location and all locations (i.e., Microphone input from the Auditorium will page in the Auditorium only. Microphone page from the Gym will page the Gym only
 - 5) Provide automatic, digitally-recorded voice messages and tones which may be field-programmed through the microphone.
 - b. The VCC shall be modular in construction. It shall be capable of being field programmed without requiring the return of any components to the manufacturer and without requiring use of external computers or other programming equipment.
 - c. The VCC and associated equipment shall be protected against unusually high voltage surges or line transients.
 - d. The VCC shall support remote fire alarm voice evacuation microphone. Remote stations shall be located at the auditorium and the gymnasium see drawings for location, coordinate exact locations with the fire department. Remote microphone and cabinet shall be similar to Notifier RM-1SA series with CAB-RMR cabinet.

L. Audio Amplifiers:

1. The Audio Amplifiers shall provide audio power (@25 Volts RMS) for distribution to speaker circuits.
2. Multiple audio amplifiers may be mounted in the FACP or in the main fire alarm control panel, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
3. The audio amplifier shall include an integral power supply, and shall provide the following controls and indicators:
 - a. Normal Audio Level LED
 - b. Incorrect Audio Level LED
 - c. Brownout LED
 - d. Battery Trouble LED
 - e. Amplifier Trouble LED
 - f. Audio Amplifier Gain Adjust
4. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
5. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
6. Amplifiers shall be backed up in groups (1 amplifier backs up several). Failure of any one amplifier in the system shall not degrade system performance in any way.
7. Speakers shall be tapped at the following minimum levels:
 - a. Corridors - 2 watts
 - b. Classrooms - 1 watt

- c. Rooms larger than 30 x 30' - 8 watts (set initially at 2 watts. Provide the system capacity to increase up to the 8 watt tap setting unless noted otherwise).
 - d. Auditorium - 8 watts.
 - e. Gymnasium - 7.5 watts.
 - f. Factory Trained, licensed authorized technical representative of the manufacturer of the equipment shall adjust taps after installation to meet code requirements.
- M. Audio Message Generator (Prerecorded Voice):
- 1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building
 - 2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times.
 - 3. A built-in microphone shall be provided to allow paging through speaker circuits.
 - 4. The message generator shall be provided to allow paging capability from telephone circuits.
 - 5. The audio message generator shall have the following controls and indicators to allow for proper operator understanding and control:
 - a. All-Call LED
 - b. On-Line LED
 - c. All-Call Switch
 - d. Local Speaker Volume Control
 - e. Local (Test) Speaker
 - 6. The prerecorded message shall be stored on a non-volatile read only memory chip. The message shall be up to 24 seconds in length. Provide the optional random access chip for a field programmable message. This message shall be programmed through the system's microphone or downloaded via a cassette recorder.
- N. Speaker Circuit Control Switches/Indicators:
- 1. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
 - 2. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.
- O. Operators Terminal: Provide the following functions in addition to any other functions required for the system:
- 1. Acknowledge (ACK/STEP) Switch:
 - a. Activation of the control panel Acknowledge switch in response to a single new alarm and/or trouble conditions shall silence the local panel piezo electric signal and change the system alarm or trouble conditions that exist or are detected and reported in the system, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
 - 1) Depressing the acknowledge switch shall also silence all remote annunciator piezo sounders.
 - 2. Signal Silence Switch: Activation of the signal silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm activation. The selection of notification circuits and relays which are silenceable by this switch shall be fully field programmable within the confines of all applicable standards.
 - 3. System Reset Switch:

- a. Activation of the system reset switch shall cause all local electronically-latched initiating devices, software zones, output devices and circuits, to return to their normal condition.
 - b. If an alarm condition(s) still exists, or if they occur in the system after system reset switch activation, the system shall then resound the alarm conditions.
 - 4. System Test Switch: Activation of the system test switch shall initiate an automatic test of all intelligent/addressable detectors in the local system. The system test shall activate the electronics in each transmission of the alarm condition from that sensor to the fire alarm control panel. The fire alarm control panel shall interpret the data from each sensor installed in the system. A report summarizing the results of this test shall be displayed automatically on the system LCD and on any CRT's or printers in the system.
 - 5. Alarm Activate (Drill) Switch:
 - a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset. Drill switch shall release all door hold open device.
 - b. The drill switch shall not Initiate the following: Signal to central receiving station(fire station) Fan shut down, smoke evacuation, and roof hatches,
 - 6. Lamp Test Switch: Activation of the lamp test switch shall sequentially turn on all LED indicators, system liquid crystal display and local piezo signal, and then automatically return the fire alarm control panel to the previous condition.
- P. Field Programming:
 - 1. The system shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.
 - 2. All local FACP node programming shall be accomplished through the FACP keyboard or through the video display terminal.
 - 3. All field defined programs shall be stored in non-volatile memory.
 - 4. The programming function shall be enabled with a password that may be defined specifically for the system when it is installed. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level is used for status level changes such as zone disable or manual ON/OFF commands. A second (higher-level) is used for actual change of program information. Passwords shall be made available to authorized personnel upon system acceptance.
- Q. Specific System Operations:
 - 1. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any and all analog intelligent detectors in the FACP node from each system keypad or from the keyboard of the video terminal. Sensitivity range shall be within allowed UL limits.
 - 2. Alarm Verification: Each of the intelligent addressable detectors in the system may be independently selected and enabled for alarm verification. Each FACP shall keep a count of the number of times each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
 - 3. System Point Operations:
 - a. All devices in the FACP node may be enabled or disabled through the local keypad or video terminal.
 - b. Any FACP node output point may be turned on or off from the local system keypad or the video terminal.

4. Point Read: The FACP node shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
 - a. Device Status
 - b. Device Type
 - c. Custom Device Label
 - d. Software Zone Label
 - e. Device Zone Assignments
 - f. Detector Analog Value
 - g. All Program Parameters
5. System Status Reports: Upon command from a password-authorized operator of the system, a status report will be generated, and printed, listing all local FACP system status.
6. System History Recording and Reporting: Each FACP node shall contain a history buffer that shall be capable of storing a minimum of 400 system events. Each local activation will be stored and time and date stamped with the actual time of the activation, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and/or printed. The history buffer shall use non-volatile memory.
7. Automatic Detector Maintenance Alert: Each FACP node shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular intelligent detector will be annunciated on the system display, network display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

2.3 SYSTEM COMPONENTS - CONVENTIONAL

- A. Speakers/Strobes: Combination Speaker/Visible signals shall be similar to Wheelock ET70-24MCW-FR.
 1. Field selectable power taps: 1/8W, 1/4W, 1/2W, 1W, 2W, 4W, 8W. (78 to 94.9 dBA).
 2. Speaker shall have Field selectable taps for 25 or 70VRMS operation.
 3. Ability to silence the speaker while leaving the visible signal active.
 4. The strobe shall be capable of meeting the candela requirements of ADA.
 5. Speaker polarized to allow electrical supervision.
 6. Speaker frequency response shall be a minimum of 400 HZ to 4000 HZ.
 7. The back of each speaker shall be protected from damage and dust.
 8. The strobe maximum pulse duration shall be 2/10 of one second.
 9. Strobe intensity shall meet the requirements of UL 1971.
 10. The strobe flash rate shall meet the requirements of UL 1971.
 11. Where more than one strobe is visible in one location, synchronization shall be required.
 12. Candela ratings: Selectable 15, 30, 75, 110, with visual indicator.
 13. Set strobe candela initially as shown on drawings. Where drawings show 15/75, then use a fixed 15/75 or set selection at 75.
 14. Red face plate with white letters.
- B. Strobe lights shall be similar to Wheelock #RSS24MC-WFR and shall meet the requirements of the ADA, UL Standard 1971 and shall meet the following criteria:
 1. The maximum pulse duration shall be 2/10 of one second.
 2. Strobe intensity shall meet the requirements of UL 1971.

3. The flash rate shall meet the requirements of UL 1971.
4. Where more than one strobe is visible in one location, synchronization shall be required.
5. Candela ratings: Selectable 15, 30, 75, 110, with visual indicator.
6. Set initially as shown on drawings. Where drawings show 15/75, then use a fixed 15/75 or set selection at 75.
7. Red face plate with white letters.

2.4 SYSTEM COMPONENTS - INTELLIGENT

A. Addressable Devices - General:

1. Addressable devices shall maintain decade (numbered 0 to 15 and 0 to 9) type address switches.
2. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the FACP signaling line circuit.
3. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LED's. Both LED's shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LED's shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
4. Smoke detector sensitivity shall be set in the fire alarm control panel and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
5. 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.
6. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature.
7. 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.
8. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
9. Detectors shall operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
10. Addressable devices shall provide address-setting means using decimal switches and shall also store use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
11. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

B. 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.
 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 surface mounting or semiflush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.
 5. Manual boxes shall be the double action type.
- C. Intelligent Photoelectric Smoke Detector: The detectors 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.
- D. Intelligent Thermal Detectors: Thermal detectors shall be intelligent addressable devices rated at 135°F. (58°C.) And have a rate-of-rise element rated at 15°F. (9.4°C.) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.
- E. Intelligent Duct Smoke Detector:
1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, that provides continuous analog monitoring and alarm verification from the panel. Include sampling tube.
 2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
 3. Whether shown on plans or not, all air handling systems operating at 2000 CFM and above shall have duct mounted smoke detection equipment in accordance with the requirements of NFPA 90A. See Air Handling Schedules on Mechanical drawings. Provide labeled remote test and indicating stations at the fire alarm control panel. Use Photoelectric type detector with duct housing and relays plus appropriate sampling tubes cut to length (width of duct).
- F. Addressable Dry Contact Monitor Module (FMM): shown on drawings as AMM (Addressable Monitor Module).
1. Addressable monitor modules shall be provided to connect 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 in a 4-inch square, 2-1/8 inch deep electrical box.
 3. The IDC zone may be wire 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.
- G. Addressable Control Module (FCM):shown on drawings as ARM (Addressable Relay Module)
1. Addressable control module 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 contact 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 back box.

3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
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 power supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of .6 amps at 30 VDC.

H. 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 floor 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 back box. 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.

I. Serially Connected Annunciator Requirements:

1. The annunciator shall communicate to the fire alarm control node or INA via an EIA-485 (multi-drop) two wire communications loop. The FACP node shall support two 6,000 ft. EIA-485 wire runs. Up to 32 annunciators, each configured up to 64 points, may be connected to connections, for a system capacity of 2,048 points of annunciation.
2. An EIA-485 repeater shall be available to extend the EIA-485 wire distance in 3,000 ft. increments. An optional (UL 864 listed) version shall allow the EIA-485 circuit to be transmitted over Fiber optics.
3. Annunciator switches may be programmed for system control such as global acknowledge, global signal silence, global system reset, and on/off control of any control point in the system.
4. An optional module shall be available utilizing annunciator points to drive EIA-485 driven relays. This shall extend the system point capacity by 2,048 remote contacts.

J. LCD Alphanumeric Display Annunciator (at remote locations):

1. The alphanumeric display annunciator shall be a supervised, back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions from either the network node or complete network, via the INA.
3. Up to 32 LCD annunciators may be connected to a specific (terminal node) EIA-485 interface. LCD annunciators shall not reduce the annunciation capacity of the system. Each LCD shall include vital system wide functions such as system acknowledge, silence and reset.
4. LCD display annunciators shall mimic the local control panel 80 character display or network annunciator and shall not require special programming.

5. Annunciator control switches for system acknowledge, signal silence, drill and reset, and localized smoke evacuation control shall be key enabled. Provide 2 keys for Owner and 2 keys for the Fire Department. (Localized smoke evacuation control shall be a Smoke Control Station with "ON-OFF-AUTO" functions to control the respective exhaust and supply units, see the Special programmable features paragraph above.)
6. Provide remote voice evacuation microphone station at the remote annunciators and in the gymnasium and auditorium.
7. AT the designated annunciator, provide a graphic annunciator of the building foot print (@1"=20' scale) with alpha numeric engraved labels indicating locations for all devices. graphic annunciator shall have all devices located for all levels and areas. The alpha-numeric display and the graphic annunciator shall be both coordinated to show initiation location by zone, area, floor, room name, device description and device number. The "area" shall be as indicated on the contract documents. The graphic annunciator shall be framed and permanently secured to wall. Exact location and layout as approved by shop drawing submittal and the fire department. The graphic annunciator shall meet fire department standards. The graphic annunciator shall have the building foot print "in phase" with the viewer and shall indicate in RED to the viewer "YOU ARE HERE". Graphic annunciator panel detail plan and drawing shall be submitted to the [Local] Fire Department for approval before installation.

K. LCD Alphanumeric Display Annunciator (within panel):

1. The alphanumeric display annunciator shall be a supervised, back-lit LCD display containing a minimum of 640 characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions from either the network node or complete network, via the INA.
3. Up to 32 LCD annunciators may be connected to a specific (terminal node) EIA-485 interface. LCD annunciators shall not reduce the annunciation capacity of the system. Each LCD shall include vital system wide functions such as system acknowledge, silence and reset.
4. Annunciator control switches for system acknowledge, signal silence, drill and reset shall be key enabled. Provide 2 keys for Owner and 2 keys for the Fire Department. All panel locks shall accept Gamewell, Simplex or FCI key.

2.5 BATTERIES

- A. Sealed lead calcium type capable of operation of the system under supervisory conditions for a minimum of 60 hours after power failure and capable of operating the alarm devices for 15 minutes during the 60 hour period. IF batteries do not fit in control panels, then remotely mount in battery cabinet in nearest storage/mech room.

2.6 AUXILIARY DEVICES

- A. Provide and install interface relays with number of poles as required (in no event less than three poles). Relays shall be Allen-Bradley, or approved equal, Bulletin 700, Type "BR" series, 120 volt coil in NEMA I enclosures. Paint enclosure red and mark "Fire Alarm Relay."
- B. Protective Wire Guards: Series G2000. Use for all horns, speaker/horns and speaker/horn light units in the Gymnasiums and locker room areas.

- C. Lexan Protective Covers: Series STI Stopper without local alarm. Use for all pull stations in the Gymnasiums and locker room areas.
- D. Provided two remote relay modules (Notifier ACM-8R).

2.7 FIELD CHARGING POWER SUPPLY (FCPS) may also be shown on the drawings as NAPX NOTIFICATION APPLIANCE POWER EXTENDER.

- A. Field Charging Power Supply: The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.
 1. The FCPS shall offer up to 8.0 amps of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.
 2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
 3. The FCPS shall include an attractive surface mount back box.
 4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
 5. The FCPS include power limited circuitry, per 1995 UL standards.
 6. Provide quantity as required to serve devices shown on plans. Locate in mechanical, electrical or storage rooms. Extend circuit from nearest emergency panelboard 120V, 20A, spare breaker. Intent is to distribute the loads to limit wire runs and voltage drop.

2.8 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Specified in Division 26 Section 260123 "Wire and Cable".
- B. Alarm System Wiring Within Building: Minimum size #16 AWG for initiating circuits and #14 AWG for alarm signal circuits, all copper-THWN, except as noted. Non power-limited wiring and exposed wiring shall be in rigid conduit or electrical metallic tubing or flexible metal conduit in accordance with Specifications for locations used, see Section 16123 - Wire and Cable: Wiring Methods. Concealed power limited wiring in dry locations above ceilings, in attic space, in stud walls, except as noted, shall be fire resistant teflon covered cables approved for use in an air plenum for fire alarm system.
 1. Cables shall be properly supported, labeled and tie wrapped.
 2. Complete installation shall meet requirements of NEC Article 760 "Fire Protective Signaling Systems."
 3. Cables shall be separated from any conductors of power or class 1 circuits and shall not enter in same conduits or J-boxes.
- C. SLC Multiplex Communication Loop: Twisted shielded pair sized per manufacturer and installed in conduit.
- D. Voice Speaker and Telephone Circuits: Twisted shielded pair sized per manufacturer.
- E. All wiring shall be per manufacturers recommendations for load and length required.

2.9 ENCLOSURES

- A. Control panels shall be housed in UL listed cabinets suitable for surface or semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and the manufacturer's standard finish. Mount flush in finished areas. All panel locks shall accept Gamewell, Simplex or FCI key.

2.10 BEACON

- A. BEACON: Edwards 48FINR-N5-255WH, red, 25watt flashing beacon 120V, 0.2 amps.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install system in accordance with manufacturer's instructions.
- B. Wiring shall be concealed in walls and above ceilings. Wiring in exposed construction shall be enclosed in conduit and run along structural members and painted to match.
- C. Minimum size conduit: 3/4 inch. Refer to above paragraph: FIRE ALARM WIRE AND CABLE.
- D. Install manual station with operating handle 48 inches above floor. Install audible and visual signal devices 80 inches above floor, or 6" below ceiling whichever is lower, except as noted.
- E. Smoke detectors shall not be installed prior to system programming and testing period. If construction is on going during this period, then protect the smoke detectors from contamination and physical damage.
- F. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, duct smoke detectors.
- G. Automatic Detector Installation: Per NFPA 72.
- H. Provide nameplates identifying all equipment, junction boxes and controls. Paint all junction boxes red.
- I. Wiring Color Code: See Division 26 Section 260195 "Electrical Identification".
- J. Homerun interface contacts from elevator lobbies detector address to labeled junction box in Elevator Machine Room. Extend to elevator control panel as directed by elevator installer. Typical for both elevators.
- K. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- L. All devices and panels shall be flush mounted in finished areas and may be surface mounted in unfinished areas such as storage rooms. Where devices are surface mounted, the back box shall be a cast red box designed to mate with the device for a smooth appearance.

- M. Provide Beacon (red, 25watt flashing beacon) mounted above the building entrance at Congress Street to flash upon the activation of the interior fire protection system.
- N. At FACP provide minimum of two ground rods with a “box connecting rod” or a #12 AWG solid copper wire, enclosed in conduit, connect to ground terminal of the Master Box. Resistance of ground connection shall not exceed 25 ohms.
- O. Wire installation shall be inspected by the fire department. Coordinate and ask for inspections from the fire department.
- P. Speakers shall be tapped at the following minimum levels:
 - 1. Corridors - 2 watts
 - 2. Classrooms - 1watt
 - 3. Rooms larger than 30 x 30' - 8 watts, (set initially at 2 watts unless noted otherwise. Provide the system capacity to increase up to the 8 watt tap setting).
 - 4. Assembly Hall - 7.5 watts.
- Q. Factory Trained, licensed authorized technical representative of the manufacturer of the equipment shall adjust taps after installation to meet code requirements.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide the services of a Factory Trained, licensed authorized technical representative of the manufacturer of the equipment to supervise the installation and final connections, plus adjusting, programming and all testing of the system required to assure a complete and fully operative facility in accordance with the specifications; and to instruct designated personnel in the operation, adjustment, testing and maintenance of the system. Provide letter certifying results of test.
- B. Include testing at substantial completion, at 6 months after occupancy and again two weeks prior to end of first year warranty. (Total of 3 complete documented tests). Invite the Owner, Architect and Local Fire Department to witness each test.
- C. Include testing of the fire alarm system audio/visual devices to assure that the signals are operating according to the guidelines set by the NFPA 72 and the Americans with Disabilities Act (ADA).
 - 1. The limitations are as follows: NFPA – “Audible signals intended for operation in the public mode should have a sound level of not less than 75 dBA at 10 feet or more than 130 dBA at the minimum hearing distance from the audible appliance.” ADA – “Audible emergency alarms shall produce a sound that exceeds the prevailing equivalent sound level in the room or space by at least 15 dBA or exceeds any maximum sound level with a duration of 60 seconds by 5 dBA, whichever is louder. Sound levels for alarm signals shall not exceed 120 dBA.”
 - 2. Test the audio/visual units and make adjustments where required, including setting volume of horns and replacing strobes with proper intensity level. If horns are not adjustable then replace for proper dB level. Submit findings in writing, with areas marked that do not meet criteria after adjustments have been made.

3.3 FIELD TEST

- A. Test in accordance with NFPA 72 and local fire department requirements. See Submittals item above.

- B. Test shall include but not be limited to:
1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
 3. Verify activation of all flow switches.
 4. Open initiating device circuits and verify that the trouble signal actuates.
 5. Open signaling line circuits and verify that the trouble signal actuates.
 6. Open and short notification appliance circuits and verify that trouble signal actuates.
 7. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.
 8. Ground initiating device circuits and verify response of trouble signals.
 9. Ground signaling line circuits and verify response of trouble signals.
 10. Ground notification appliance circuits and verify response of trouble signals.
 11. Check alert tone and prerecorded voice message to all alarm notification devices.
 12. Check installation, supervision, and operation of all intelligent smoke detectors using walk test.
 13. Each of the alarm conditions that the system is required to detect shall 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 panel points.
 14. When the Vendor determines that the system must be equipped with optional features to satisfy this specification, the manufacturer's manual shall 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.

3.4 FINAL INSPECTION

- A. A factory trained representative shall demonstrate that the system functions as specified.
- B. Demonstrate in the presence of the Owner, Local Fire Chief, and the contractor. Invite the Architect's representative.

3.5 INSTRUCTIONS

- A. In addition to the site training on programming features previously specified, provide minimum of two four hour periods to instruct the owner in the proper operation and maintenance requirements of the system. Provide one four hour period at substantial completion (after all testing and the system is fully operational and accepted by the fire department) and the other four hour period six months after substantial completion.
- B. Provide a typewritten, bound, laminated "Sequence of Operation" to the Owner.

END OF SECTION 260721

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SECTION 260723 - INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Complete Intrusion detection system including but not limited to:
- B. Equipment, materials, labor, installation, connection, programming, testing, training, reporting of fire alarm and performance of all operations of the system as indicated on the drawings and as herein specified.
- C. Initiating devices, notification appliances, intrusion alarm control panel (IDS) U.L. listed for both fire alarm and burglar, auxiliary control devices, annunciators, and wiring.
- D. Connection to the Card Access System for disarming the IDS system.
- E. Notification of intrusion detection and fire alarm to the Owner's choice of Central Receiving Station(s).

1.2 RELATED SECTIONS

- A. Section 260100 – "Basic Electrical Requirements".

1.3 REFERENCES

- A. NFPA 70 (N.E.C.) latest edition.
- B. U.L. Standards.
- C. FM Factory Mutual
- D. NFPA 72 National Fire Alarm Code.
- E. ADA - Americans with Disabilities Act.
- F. NFPA 101 - Life Safety Code.
- G. Local and State Codes.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of NFPA 70. (N.E.C.), specifically Art 760.
- B. Conform to requirements of the National Fire Protection Association, Standards NFPA 72 NFPA 101 and also all applicable Federal, State and local codes.
- C. All requirements of the Authority Having Jurisdiction (AHJ).

- D. All components of the same manufacturer, FM approved and listed by Underwriters' Laboratories, Inc., and so labeled.
- E. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown. The control panel, network interface and all transponders shall meet the modular labeling requirements of U.L. Each subassembly, including all printed circuits, shall include U.L. modular labels.
- F. Include all necessary software, programming and the selection of the proper type and quantities of the system components to assure a complete, operational, and Code Compliant System.
- G. System shall be completely field programmable.
 - 1. Provide the Owner with all required components, interfaces and passwords to allow them full access to the programming features. Provide minimum of 8 hours on site training on programming features.
 - 2. Provide all hardware, software, programming tools, and documentation necessary to allow modifying the fire alarm network on site. Modifications include addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices and zones.
 - 3. The system structure and software shall place no limit on the type and extent of ON-SITE software modifications. Software modification shall not require power shut down of system and shall not cause loss of system fire protection while making modifications.
- H. Special programmable features:
 - 1. Generator monitoring.
- I. The drawings do not show all details of the Alarm System. It shall be the responsibility of the authorized supplier/installer to provide a fully operational code compliant system.

1.5 ALARM DESCRIPTION

- A. Alarm System: Shall communicate to the Owner's choice of a Central Receiving Station.

1.6 INTRUSION DESCRIPTION

- A. Alarm System: Electrically-supervised automatic alarm system capable of transmitting all input zones to the Central Receiving Station. Status inputs shall include Motion sensors, door switches, and inputs from automatic transfer switch.
- B. Entry/Exit Sequence.
 - 1. Entering at front door begins delay timer to allow disarming.
 - 2. Arm/disarm via key pad with alpha numeric display at the front entry, disarm at a designated card reader (access control system).
 - 3. Disarm: Display reads: "ALL SECURE". Authorized person enters alarm delayed entry doors and inputs security code at key pad. System is disarmed and display reads: "READY TO ARM".
 - 4. ARM: Display reads: "READY TO ARM". Authorized person inputs security code. Display flashes "ALL SECURE / READY TO ARM" for a preset time then displays constant "ALL SECURE". System now armed.
 - 5. System may be armed by zones.

6. Individual zones may be bypassed to force arm the system.
- C. System Supervision:
1. Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode.
 2. Component or power supply failure places system in TROUBLE mode.
 3. Occurrence of single ground or open condition on alarm initiating or signaling circuits does not disable that circuit from transmitting in ALARM whether device is upstream or downstream of break.
 4. Batteries: Under or over battery voltage, shorted or disconnected battery supply places system in TROUBLE mode.
 5. All end of line devices shall be located in control panel.
- D. Alarm Sequence of Operation: Actuation of any initiating device causes system to enter ALARM, which includes the following operations:
1. Silent alarm at the Intrusion Detection panel.
 2. Indicate location of alarm zone on alpha numeric display.
 3. Energize a digital electronic communicator to transmit signals to the Owner's central receiving station.
 4. Alarm Reset: Key pad RESET function resets alarm system to NORMAL condition (out of ALARM) if alarm initiating circuits have cleared.
- E. Trouble Sequence of Operation: System trouble, including grounding or open circuit of supervised circuits, or power or system failure causes system to enter TROUBLE mode, including the following operations:
1. Visual and audible trouble alarm by zone at the alpha numeric display panel.
 2. Key pad ACKNOWLEDGE function (trouble silence) silences audible trouble alarm; visual alarm is displayed until initiating trouble is cleared.
- F. Central Receiving Station signals to be transmitted as listed on schedule.
- G. Intrusion detection of all perimeter doors plus any interior doors shown with magnetic switches.
- H. Intrusion detection of Corridors and Assembly Hall as indicated with motion detectors.

1.7 QUALIFICATIONS

- A. Alarm equipment Manufacturer:
1. Company specializing in manufacturing the products specified in this Section with minimum five years documented experience.
 2. Company maintaining engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.
- B. Supplier/Installer (Vendor):
1. Company authorized by the manufacturer and specializing in fire alarm systems with minimum five years experience.
 2. Company shall employ NICET (minimum Level II fire alarm technology) technicians.
 3. Company offering service contracts for continuing factory authorized service after the initial warranty period.

1.8 SUBMITTALS

- A. Include floor plans showing all devices, wiring, and connections: Plan layout, connection diagrams and catalog cuts of all components.
- B. Include narrative description of system functions and sequence of operation.
- C. Include catalog cuts of all equipment, devices, annunciator layout, control panel modules, and internal terminal configurations.
- D. Include documentation showing proof of U.L. listing for all system components.
- E. Include all cable types.
- F. Include second year extended service contract listing services included and costs. The cost of this service contract is included under this section.
- G. Submit manufacturer's instructions.

1.9 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations and mounting heights of outlets if not as shown on Drawings, plus pull and junction boxes larger than 12x12x6 inches.
- B. Accurately record actual routing of conduits larger than 1 inch and main wiring trunks.

1.10 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- C. Include operating instructions, and maintenance and repair procedures.
- D. Include manufacturer's representative's letter stating that system has been tested and is operational.

1.11 EXTRA MATERIALS

- A. Provide one motion detectors.
- B. Provide one contact magnetic switches of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Honeywell/ADEMCO: Model numbers used except as noted.
 - 1. Or equivalent /equal.

2.2 CONTROL PANEL

- A. Control Panel: VISTA-128FB series, modular construction wall-mounted enclosure, supervised, battery operated system, 128 zones, with 8 programmable area partitions. Modules shall include, but not be limited to, the following:
 - 1. Zone modules.
 - 2. Power signal modules.
 - 3. Battery charger module.
 - 4. Battery pack.
 - 5. Auxiliary Relays: Minimum one SPDT contact for each detection zone for remote annunciation, plus additional contacts to provide accessory functions specified.
 - 6. Battery-operated emergency power supply with capacity to operate the batteries herein specified.
 - 7. Digital communicator. Digital communicator shall be compatible with the owners choice of central receiving station provide all modules and programming required. Digital communicator shall be complete with line seizure, battery backup.
 - 8. Communication Features - Supports the following formats and features for the primary and secondary central station receivers:
 - a. Formats
 - 1) ADEMCO Low Speed (Standard or Expanded).
 - 2) Sescoa/Radionics.
 - 3) ADEMCO Express.
 - 4) ADEMCO High Speed.
 - 5) ADEMCO Contact ID.
 - 6) Long-Range Radio Interface.
 - b. Backup reporting – The system shall support backup reporting via the following:
 - 1) Secondary phone number.
 - 2) ECP long-range radio (LRR) interface.
 - 3) Option to select long-range radio (LRR) or dialup as the primary reporting method (dynamic signaling feature).
 - c. Provide all equipment and components including but not limited to an external communicator to interface to the central receiving station if the Owner's central receiving station does not utilize one of the above formats.
- B. System shall support up to eight (8) separate areas (partitions).
- C. System shall support up to 512 event log and 96 relay outputs.
- D. Batteries: Sealed lead calcium type capable of operation of the system under supervisory conditions for a minimum of 60 hours after power failure and capable of operating the alarm devices for 15 minutes during the 60 hour period.

2.3 SYSTEM COMPONENTS - INTELLIGENT

- A. Addressable Dry Contact Monitor Module (Ademco SIMMs module).
- B. LCD Alphanumeric Display Annunciator (at panel and remote locations):
 - 1. The alphanumeric display annunciator shall be a supervised, back-lit LCD display containing a minimum of 32 characters for alarm annunciation in clear English text.

2.4 INTRUSION INITIATING DEVICES

- A. Motion Detectors: Bosch (Detection Systems) - Wall mounted, DS720i series long range tritech detector with swivel mount bracket, field changeable mirrored optics. Provide specific detectors as required to provide coverage as indicated, intended and required.
- B. Recessed Magnetic Door Switches: GE (Sentrol) 1076D series DPDT with three foot lead wires. Select proper size and gap as required. (Two switches each with a three foot lead.) Or equal by Honeywell.
- C. Surface Magnetic Door Switches: GE (Sentrol) series DPDT with three foot lead wires. Select proper size and gap as required. (Two switches each with a three foot lead.) Or equal by Honeywell.
- D. Roof scuttle switches: surface mounted GE Sentrol #2507A series SPDT magnetic industrial wide gap series with three foot stainless steel flex conduit.

2.5 BATTERIES

- A. Sealed lead calcium type capable of operation of the system under alarm conditions for a minimum of 60 hours after power failure and capable of operating the alarm devices for 15 minutes during the 60 hour period.

2.6 ALARM WIRE AND CABLE

- A. Alarm Power Branch Circuits: Specified in Section 260123 "Wire and Cable".
- B. Alarm System Wiring Within Building: size and type per manufacturers requirements
- C. Telephone Circuits: Twisted shielded pair sized per manufacturer.
- D. All wiring shall be per manufacturers recommendations for load and length required

2.7 ENCLOSURES

- A. Control panels shall be housed in UL listed cabinets suitable for surface or semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and the manufacturer's standard finish. Mount flush in finished areas.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install system in accordance with manufacturer's instructions.
- B. Wiring shall be concealed in walls and above ceilings. Wiring in exposed construction shall be enclosed in conduit and run along structural members and painted to match.
- C. Locate motion detectors to maximize area covered. Do not install behind obstructions.
- D. Install concealed magnetic door switches with magnet in top of door on latch side and wired contact in door frame. Align for proper operation. Select proper type and gap for type of door used. Provide mud box in door frame where required to protect device from plaster or mortar. Fish wire lead in door frame and into flexible conduit to an accessible junction box. Where the door frame does not allow for concealed installation verify with the architect to allow surface mounting of door switch.
- E. Install surface switches for roof hatches with magnet on interior of latch side of hatch and wired contact on fixed frame. Align for proper operation. Select proper type and gap for type of hatch used. Secure flex leader to frame and junction box.
- F. Each motion detector initiating device shall have 4 wire supervised home run directly to panel and shall display as separate zones. Series wiring of multiple devices shall not be allowed.
- G. Each door switch (magnetic contact) shall have a supervised home run directly to panel and shall display as separate zones. Series wiring of multiple devices shall be allowed only where the doors are grouped at a location and serve the same space/room, (i.e. the four door switches at the main entrance double doors (four leafs) can be grouped and series wired back to the control panel). Each door switch shall have one set of leads for the IDS and the second set reserved for the card access system. Label leads for the card access system and coordinate with the card access vendor.
- H. Provide nameplates identifying all equipment, junction boxes and controls.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide the services of a Factory Trained, licensed authorized technical representative of the manufacturer of the equipment to supervise the installation and final connections, plus adjusting, programming and all testing of the system required to assure a complete and fully operative facility in accordance with the specifications; and to instruct designated personnel in the operation, adjustment, testing and maintenance of the system. Provide letter certifying results of test.
- B. Include testing at substantial completion, at 6 months after occupancy and again two weeks prior to end of first year warranty. (Total of 3 complete documented tests). Invite the Owner, Architect and Local Fire Department to witness each test.

3.3 FIELD TEST

- A. Test in accordance with manufacturer's requirements.
- B. Test shall include but not be limited to:
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. When the Vendor determines that the system must be equipped with optional features to satisfy this specification, the manufacturer's manual shall 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.

3.4 FINAL INSPECTION

- A. A factory trained representative shall demonstrate that the system functions as specified.
- B. Demonstrate in the presence of the Owner, Local Fire Chief, and the contractor. Invite the Architect's representative.

3.5 INSTRUCTIONS

- A. In addition to the site training on programming features previously specified, provide minimum of two four-hour periods to instruct the owner in the proper operation and maintenance requirements of the system. Provide one four-hour period at substantial completion (after all testing and the system is fully operational and accepted by the fire department) and the other four-hour period six months after substantial completion.
- B. Provide a typewritten, bound, laminated "Sequence of Operation" to the Owner.

END OF SECTION 260723

SECTION 270010 - VOICE/DATA SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes the following:
 - 1. Voice/Data Connectivity: Cable and terminations between Patch Panels and Station Outlets.
 - 2. Voice/Data cabling system terminated in labeled rack mounted modular patch panels, terminated per ANSI/TIA/EIA assignments as directed by owner with Category 6A cable tested to Cat 6A specifications.
 - 3. Voice, data outlets and faceplates.
 - 4. Termination patch panels, in two-post rack.
 - 5. Complete installed and tested data cabling system.
 - 6. J-Hooks to manage cabling.

1.2 SECTION DOES NOT INCLUDE

- A. Wiring pathways; Coordinate with Section 260010 Basic Electrical Requirements.

1.3 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section. Examine all contract documents for requirements affecting the work.

1.4 REFERENCES

- A. In addition to appropriate standards identified in other sections of this specification, the installation of voice/data systems shall conform to the following:
 - 1. NFPA 70 (NEC) latest edition.
 - 2. ANSI/TIA/EIA Standards (telecommunications industry association standards - all applicable with addenda) latest edition. When items or systems have been specified and standards have not yet been adopted by ANSI/TIA/EIA, the latest proposed standard at the time of installation shall be used.
 - a. ANSI/TIA/EIA-568B.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements
 - b. ANSI/TIA/EIA-568B.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balance Twisted-Pair Cabling Components
 - c. ANSI/TIA/EIA-568B.2-1 - Commercial Building Telecommunications Cabling Standard - Part 2: Balance Twisted-Pair Cabling Components Addendum 1 - Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling.
 - d. ANSI/TIA/EIA-569A - Commercial Building Standard for Telecommunication Pathways and Spaces
 - e. ANSI/TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - f. ANSI/TIA/EIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications

1.5 QUALITY ASSURANCE

- A. Telephone Utility Company: Scott Derrig, FairPoint Communications, (207) 797-1866.
- B. Install work in accordance with Telephone Utility Company's rules and regulations.
- C. Product and System Certification:
 - 1. The voice/data communications systems shall be furnished, installed and tested as a category 6A system.
 - 2. All individual components furnished shall be designed, manufactured, tested and certified to meet the standards for the system category for which they were furnished.
 - 3. The installed system(s) shall be installed, tested and carry a A system certification and warrantee that it meets the standards for the system category specified.
- D. Qualifications:
 - 1. Company specializing in the installation of voice/data and fiber optic system connectivity with a minimum of five years experience.
 - 2. Company shall possess licenses/permits required to perform voice/data installations in the project jurisdiction.
 - 3. The company shall be registered with BICSI and have at least one RCDD on staff. In lieu of an on-staff RCDD the contractor may sub-contract the services of an RCDD to provide contractor design and construction oversight and to supervise all testing. Provide a minimum of 40 hours of RCDD field time during construction plus time to document field notes. A minimum of five site visits shall be made during construction. In addition, provide on-site services of an RCDD to supervise all testing and certification.
 - 4. The contractor shall have previous experience in installing systems of the category specified. Provide qualified technicians with extensive backgrounds in data/communications and fiber optic installation, termination and testing. Personnel shall be trained and certified in the design and installation of the cabling system provided by the system manufacturer. Personnel certifications shall be current and updated by attending a manufacturer's re-certification class at least every two years.
 - 5. Company shall offer service contracts for continuing service after the initial warranty period.

1.6 SUBMITTALS

- A. Include racks, wire management, devices, wire and cable, performance characteristics, details for labeling and color coding.
- B. Include cable attenuation and NEXT specifications.
- C. Test results: Provide in labeled three ring binder showing test results of all station runs. Each test shall be labeled with station ID. Include data on testing equipment, including manufacturer, model number, date last tested.

1.7 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations and mounting heights of outlets if not as shown on Drawings, plus cable routing.

1.8 PRODUCT HANDLING

- A. Delivery and Storage: Job materials shall be kept dry and protected at all times. Protect against exposure to wet weather and contact with damp or wet surfaces.

1.9 PROJECT CONDITIONS

- A. Wire and cable routing is not shown on Drawings. Route wire and cable as required to meet project conditions.
- B. Determine exact routing, number of conductors and lengths required.

1.10 COORDINATION

- A. Locate such that outlets are readily accessible.
- B. Determine required separation between cable and other work.
- C. Determine cable routing to avoid interference with other work.
- D. Verify exact device type and configuration plus color coding prior to shop drawing submittals.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide products for a category 6A voice/data communications system.
- B. Products shall be individually tested and shall be certified to meet, by the manufacturer, the individual component test standards for the category system in which they will be applied.
- C. The completed communication system(s) shall be tested from patch panel to each station drop. Test results shall be verified and certified by the system components manufacturer to provide the category performance specified. The components manufacturer shall provide a minimum 15 year systems performance warranty.
- D. Product catalog numbers indicated are based on a Siemons/Comm Scope solution unless otherwise indicated. Numbers are latest available. Update model numbers as required to assure conformance to latest approved category 6 standards. The following manufacturers with warrantied solutions will be considered for approval.
 - 1. Manufacturer:
 - a. Siemons
 - b. Hubbell
 - c. Superior Modular Products
 - d. Panduit.
 - e. Krone
 - f. NORDX
 - g. Approved equal.

2.2 COMMUNICATION DISTRIBUTION RACKS

- A. Racks shall be 7 foot high by 19 inch wide racks, black, provided with both vertical and horizontal cable management and equipped as shown and/or specified. Vertical cable management shall be provided although not specifically detailed on drawings. Vertical cable organizers shall be provided on each end of the rack assembly and one between each rack 19 inch section.
- B. Equipment racks sections - 7' H x 19" W, 45 rack units, black Hubbell HPW84RR19.
- C. Grounding Strap: 16 position grounding strap rack.
- D. Vertical cable organizers: 4 ½" wide, vertical "Z" channel, black, Hubbell VS74
- E. Horizontal cable organizers - 7 split "D"-Rings, 6 pass through holes, hinged cover duct, Hubbell HC219CC3N

2.3 CAT 6 COPPER SYSTEM 48-PORT PATCH PANELS:

- A. Rack mounted 48-port Hubbell Nextspeed cat 6 patch panel, two rack units high (2UPPP) with clear plastic label holders, #P6E48U.
- B. Provide quantity of patch panels to receive all cables plus 20%.
- C. Voice and Data cables shall terminate on separate patch panels.

2.4 COPPER TERMINATIONS

- A. Terminal Blocks:
 - 1. Acceptable Manufacturers:
 - a. AT&T, Model #110 Series.
 - b. Leviton.
 - 2. Wiring Block: Fire-retardant molded plastic, 100 pair block with horizontal index strips to secure 25 cable pairs each.
 - a. Self-supporting with legs to provide space behind the block for cables terminated on the wiring block and space on the sides for vertical jump through.
 - b. Index Strips: Designed to accept 22 through 26 gauge conductors and marked with five tip colors.
 - 3. Connecting Block: 4-pair insulation displacement 1-piece fire-retardant plastic double ended unit.
 - a. Termination End: Solder-plated quick clips that cut through the insulation when pushed onto the wiring block.
 - b. Cross Connect End: Designed to accept 22 through 26 gauge wires without removing the insulation.
 - c. Front color coded per owner requirements.
 - d. Quantity as required to cover all index strips specified.
 - 4. As a minimum, provide number of blocks to receive all outlets shown plus 50%.

2.5 COMMUNICATION OUTLETS

- A. Based on Hubbell solutions or approved equal.
 - 1. White, modular type, front loading. Provided with outlet configurations indicated.
 - 2. All unused openings shall be provided with blanks.
 - 3. Single gang plate frames: IMF1W (Total 6 unit modules)
 - 4. Double gang IMF2W (Total 6 unit modules per gang)
 - 5. Equal to Hubbell "Xcelerator" with front loading keystone modules to receive devices indicated.
- B. Wall phone face plates shall be stainless steel single outlet designed to accept wall-mounted phone.
- C. Jacks shall be identified as voice or data (Green for Voice/Blue for Data).

2.6 WIRE AND CABLE

- A. Acceptable Manufacturers: Cable manufacturers certified as Hubbell Cable Partners including:
 - 1. Comm Scope, General Cable, Mohawk/CDT, Superior Essex, Berk-Tek, Approved equal.
- B. Inside Plant Voice/Data Cat 6 Copper Cable:
 - 1. 100 Ohm balanced, 4 pair, 24 gauge, UTP.
 - 2. UL MPR/CMR, Non-Plenum, Riser-Rated.
 - 3. Flame retardant PVC jacket.
 - 4. Jacket color: Green for Voice and Blue for Data.

2.7 BACKBOARDS

- A. Material: APA Plywood Grade AC.
- B. Size: 3/4 inch thick, 4 x 8 feet for main backboard, minimum 4x4 feet for satellite backboards or as shown on Drawings.
- C. Paint all sides two coats Dark Gray.
- D. Provide copper ground wire terminated on copper ground bus - see specifications.

2.8 WIRING PATHWAYS & SUPPORTS

- A. Caddy Cable cat Clips or equal (J-hooks)
 - 1. Assembly clip spacing shall not exceed four (4) feet (Random 3' to 4'). Spacing shall allow no more than 12 inch cable sag at mid span.
 - 2. Cable Attachment: Secure all cables to assemblies/clips with velcro ties.
 - 3. Accessories and Fittings: Manufacturer's standard clamps, hangers, brackets.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify that field measurements are as shown on Drawings.
- C. Verify that building is watertight before start of installation. Do not install cable until building is water-tight.

3.2 INSTALLATION

- A. Coordinate pathways with Division 26.
- B. Support all cables above ceiling from on J-hooks tied loosely with Velcro straps, Maintain separation between voice and data cables and limit cable in bundles to 12 cables maximum.
- C. Install and terminate connectivity in accordance with manufacturer's guidelines for the equipment specified.
- D. Label each station outlet and port on patch panel with Rack number, room number and station number. Verify labeling with Owner.
- E. Color coding of individual wires for data shall match Owner's standard color code system. Contractor to confirm with Owner.

3.3 TESTING

- A. Testing of all newly installed cable channels shall be performed prior to system cut over.
- B. General Copper Testing:
 - 1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568.
 - 2. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
 - 3. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated.
 - 4. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance
- C. Cat6 Copper Testing:
 - 1. All category 6A field testing shall be performed with an approved digital level 3 balanced twisted-pair field test device.
 - 2. All installed category 6A channels shall perform equal to or better than the minimum

requirements listed in ANSI/TIA/EIA-568B.2-1.

3. All Category 6A balanced twisted-pair cables shall be 100 percent tested according to ANSI/TIA/EIA-568-B.1. Test parameters include wire map, length, NEXT loss (pair-to-pair), and NEXT loss (power sum, ELFEXT loss (pair to pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.
 4. Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to outlet. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number.
 5. Test equipment criteria
 - a. All balanced twisted-pair field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing.
 - b. Autotest settings provided in the field tester for testing the installed cabling shall be set to the default parameters.
 - c. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.
- D. Replace and retest all cable that does not meet the minimum requirements.

3.4 ADMINISTRATION AND DOCUMENTATION

A. Labeling:

1. Horizontal cables shall be labeled at each end. The cable or its label shall be marked with its identifier.
2. A unique identifier shall be marked on each faceplate to identify it as connecting hardware.
3. Each port in the faceplate shall be labeled with its identifier
4. A unique identifier shall be marked on each piece of connecting hardware to identify it as connecting hardware.
5. Each port on the connecting hardware shall be labeled with its identifier.

B. Drawings: As-built drawings shall be supplied by the Contractor showing the locations of and identifiers for all cable routing and terminations.

C. Records:

1. All records shall be created by the installation Contractor and turned over at the completion of work.
2. The format shall be computer based and both soft copies and hard copies shall be part of the As-built package. The minimum requirements include:
 - a. Cable records must contain the identifier, cable tray, termination positions at both ends, splice information as well as any damaged pairs/conductors.
 - b. Connecting hardware and connection hardware position records must contain the identifier, type damaged position numbers, and references to the cable identifier attached to it.
 - c. Test documentation on all cable types shall be included as part of the As-built package.

D. Reports: All reports shall be generated from the computer based program to create the records above. These reports should include but not be limited to the following:

1. Cable reports.

2. Cross-connect reports.
3. Connecting hardware reports.

3.5 SYSTEM WARRANTY

A. A minimum 15 year warranty for the category 6A structured cabling system shall be provided for the end-to-end channel model installation which shall cover applications, assurance, cable, connecting hardware and the labor cost for the repair or replacement thereof.

B. Additional Features of the Warranty Shall Include:

1. Margin over category 6 channel specifications on all parameters across the entire frequency range of 1-250 Mhz as noted below: Manufacturer shall publish and submit their values in the following form:

Parameter	Guaranteed Margin 1-250 Mhz (dB)
Insertion loss	dB
NEXT loss	dB
PS NEXT loss	dB
ACR	dB
PS ACR	dB
ELFEXT	dB
PS ELFEXT	dB
Return loss	dB
Propagation Delay	ns
Delay Skew	ns

2. Performance claims based on worst case testing and channel configurations.
3. Applications shall not exceed bit error rates specified by IEEE, ATM Forum, ANSI and ISO standards for all current and future applications operating on compliant LAN equipment that has been designed for use with a compatible category or class of balanced twisted-pair cabling.

END OF SECTION 270010

SECTION 321816.13 - PLAYGROUND PROTECTIVE SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Organic loose-fill surfacing.

1.3 DEFINITIONS

- A. Definitions in ASTM F 2223 apply to Work of this Section.
- B. Critical Height: Standard measure of shock attenuation according to ASTM F 2223; same as "critical fall height" in ASTM F 1292. According to ASTM F 1292, this approximates "the maximum fall height from which a life-threatening head injury would not be expected to occur."
- C. Unitary Surfacing: A protective surfacing of one or more material components bound together to form a continuous surface; same as "unitary system" in ASTM F 2223.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of protective surfacing.
 - 1. Include plans, sections, placement details, and attachment to substrates.
 - 2. Include accessories and edge terminations.
 - 3. Include fall heights and use zones for equipment and structures specified in Section 116800 "Playground Equipment and Structures," coordinated with the critical heights for protective surfacing.
- C. Samples for Initial Selection: For each type of exposed finish.
 - 1. Include Samples of accessories involving color selection.
- D. Samples for Verification: For each type of protective surfacing and exposed finish.
 - 1. Include Samples of accessories to verify color and finish selection.
 - 2. Loose-Fill Surfacing: Minimum 1 quart.
 - 3. Drainage/Separation Geotextile: Minimum 12 by 12 inches.
 - 4. Drainage Panel: Minimum 6 by 6 inches.
 - 5. Weed-Control Barrier: Minimum 12 by 12 inches.
- E. Product Schedule: For protective surfacing use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installer.
- B. Material Certificates: For each type of loose-fill surfacing.
- C. Product Certificates: For each type of unitary surfacing product.
- D. Field quality-control reports.
- E. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For playground protective surfacing to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Loose Fill: Amount equal to five percent of amount installed.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace components of protective surfacing that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Reduction in impact attenuation as measured by reduction of critical fall height.
 - b. Deterioration of protective surfacing and other materials beyond normal weathering.
 - 2. Warranty Period: As provided by manufacturer of material approved by Landscape Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain protective surfacing materials, including loose-fill accessories, from single source from single manufacturer.
 - 1. Provide geosynthetic accessories of each type from source recommended by manufacturer of protective surfacing materials.

2.2 PERFORMANCE REQUIREMENTS

- A. Impact Attenuation: Critical fall height tested according to ASTM F 1292.
- B. Accessibility Standard: Minimum surfacing performance according to ASTM F 1951.

2.3 ORGANIC LOOSE-FILL SURFACING

- A. Engineered Wood Fiber: ASTM F 2075; containing no bark, leaves, twigs, or foreign or toxic materials; tested for accessibility according to ASTM F 1951.
 - 1. Critical Height: As indicated on Drawings.
 - 2. Uncompressed Material Depth: Not less than as indicated on Drawings.

2.4 LOOSE-FILL ACCESSORIES

- A. Edging: Anchored-in-place, weather-resistant containment barrier designed to minimize sharp edges, protrusions, and tripping hazards; formed by interconnected, modular units.
 - 1. Polyethylene Units: UV-light-stabilized, 100 percent recycled; made into smooth-surfaced straight and curved units with radiused exposed edges and integral, molded-in color; in manufacturer's standard sizes.
 - a. Color: As selected by Landscape Architect from manufacturer's full range.
 - 2. Anchor Stakes: Manufacturer's standard, of corrosion-resistant-coated metal or noncorrodible material, designed to be nonprotruding when installed, for connecting units and securing in-place.

2.5 GEOSYNTHETIC ACCESSORIES

- A. Drainage/Separation Geotextiles: Comply with Section 312000 "Earth Moving."
- B. Drainage/Separation Geotextile: Nonwoven, needle-punched geotextile, manufactured for drainage applications and made from polyolefins or polyesters; with the following minimum properties:
 - 1. Weight: 4 oz./sq. yd. ASTM D 5261.
 - 2. Water Flow Rate: 100 gpm/sq. ft. according to ASTM D 4491.
- C. Drainage Panel: Prefabricated, composite drainage panels made with drainage core and filter fabric.
 - 1. Drainage Core: Three-dimensional, non-biodegradable, molded-plastic-sheet material designed to effectively drain water under maximum fill pressures.
 - 2. Fabric: Nonwoven, needle-punched geotextile, specifically manufactured as a filter geotextile and made from polyolefins or polyesters; with the following minimum properties:
 - a. Weight: 4 oz./sq. yd. according to ASTM D 5261.
 - b. Water Flow Rate: 100 gpm/sq. ft. according to ASTM D 4491.
 - 3. Minimum Flow Rate: 9 gpm/foot according to ASTM D 4491.
- D. Weed-Control Barrier: Composite fabric geotextile consisting of woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, weighing not less than 4.0 oz./sq. yd.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for subgrade elevations, slope, and drainage and for other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and without high spots, ridges, holes, and depressions.
- B. Hard-Surface Substrates: Verify that substrates are satisfactory for unitary, protective surfacing installation and that substrate surfaces are dry, cured, and uniformly sloped to drain within recommended tolerances according to protective surfacing manufacturer's written requirements for cross-section profile.
 - 1. Asphalt Substrates: Verify that substrates are dry, sufficiently cured to bond with adhesive, and free from surface defects, dust, dirt, loose particles, grease, oil, and other contaminants incompatible with protective surfacing or that may interfere with adhesive bond.
 - 2. Concrete Substrates: Verify that substrates are dry and free from surface defects, laitance, glaze, efflorescence, curing compounds, form-release agents, hardeners, dust, dirt, loose particles, grease, oil, and other contaminants incompatible with protective surfacing or that may interfere with adhesive bond. Determine adhesion, dryness, and acidity characteristics by performing procedures recommended in writing by protective surfacing manufacturer.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates to receive surfacing products according to protective surfacing manufacturer's written instructions.
- B. Hard-Surface Substrates: Clean surface free of laitance, efflorescence, curing compounds, and other contaminants incompatible with protective surfacing.
 - 1. Repair: Fill holes and depressions in unsatisfactory surfaces with leveling and patching material.
 - 2. Treatment: Mechanically abrade or otherwise prepare concrete substrates according to protective surfacing manufacturer's written instructions to achieve adequate roughness.
 - 3. Terminal Edges: Saw cut concrete and asphalt for terminal edges of protective surfacing.
 - 4. Treat control joints and other nonmoving substrate cracks to prevent telegraphing through protective surfacing.

3.3 INSTALLATION OF GEOSYNTHETIC ACCESSORIES

- A. Install geosynthetic accessories before edging and according to playground surface system manufacturer's and geosynthetic manufacturer's written instructions and in a manner that cannot become a tripping hazard.
 - 1. Drainage/Separation Geotextile: Completely cover area beneath protective surfacing, overlapping geotextile sides and edges a minimum of 8 inches with manufacturer's standard treatment for seams.

2. Drainage Panels: Completely cover area beneath protective surfacing, abutting the drainage cores and overlapping seams with geotextile fabric facing with adhesively bonded seams.
3. Weed-Control Barrier: Completely cover area beneath loose-fill installation, overlapping barrier edges a minimum of 8 inches with adhesively bonded or taped seams.

3.4 INSTALLATION OF LOOSE-FILL SURFACING

- A. Apply components of loose-fill surfacing according to manufacturer's written instructions to produce a uniform surface.
- B. Edging: Place and permanently secure edging in place, and attach units to each other.
- C. Loose Fill: Place loose-fill materials to required depth after installation of playground equipment support posts and foundations. Include manufacturer's recommended amount of additional material to offset natural compaction over time.
- D. Grading: Uniformly grade loose fill to an even surface free from irregularities.
- E. Compaction: After initial grading, mechanically compact loose fill before finish grading.
- F. Finish Grading: Hand rake to a uniformly smooth finished surface and to required elevations.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests.
- B. Perform the following tests with the assistance of a factory-authorized service representative:
 1. Perform "Installed Surface Performance Test" according to ASTM F 1292 for each protective surfacing type and thickness in each playground area.
 2. Perform installed-surface-performance tests at no less than one series of tests for each 500 sq. ft. of each type and thickness of in-place protective surfacing or part thereof.
- C. Playground protective surfacing will be considered defective if it does not pass tests.
- D. Prepare test reports.

END OF SECTION 321816.13

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SECTION 321843- STONE MULCH AND STONE DUST SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 - GENERAL REQUIREMENTS which are hereby made a part of this section of the specifications.

1.2 SUMMARY

- A. Provide all labor, equipment, implements and materials required to furnish, construct and install items as shown on the Drawings and specified herein:
 - 1. Peastone mulch
 - 2. Stone dust surfacing
- B. Related Requirements: The following items of work are not included in this Section and are specified under the designated Sections:
 - 1. Section 312213 Rough Grading.
 - 2. Section 321843 Stone Mulch and Sand Surfacing
 - 3. Section 329115 Soil Preparation.
 - 4. Section 329200 Turf and Grasses.
 - 5. Section 329300 Plants.

1.3 QUALITY ASSURANCE

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
- B. Workmanship: The Contractor is responsible for correction of metal fabrication work which does not conform to the specified requirements, including strength, tolerances and finishes. Correct deficient work as directed by the Architect.
- C. Peastone surface work, shall be done only after other excavation and construction work which might damage or disturb the installed surface has been completed. Damage caused during other construction shall be repaired before acceptance.
- D. Site grading, placement of cement concrete footings and slab shall be completed before the installation of the peastone surface.
- E. Peastone surface shall not be installed on a muddy or frozen subgrade.
- F. Other components of the Work, if damaged or removed during the course of peastone surface installation, shall be repaired or replaced as directed by the Owner
- G. Construction tolerances for work installed under this section shall apply to exposed surfaces of work as follows:

1. Variation from Plumb: For lines and surfaces, not to exceed one-eighth inch (1/8") in five feet (5').
2. Variation from Level or Parallel: For dimensions shown and other conspicuous lines, not to exceed one-eighth inch (1/8") in ten feet (10') for level line.

1.4 PREINSTALLATION MEETING

- A. Pre-installation Conference: Conduct conference at the proposed neighborhood center to be constructed at 1342 Congress Street in Portland, Maine.

1.5 ACTION SUBMITTALS

- A. Product data: for each type of product submit manufacturer's or supplier's product data for all materials specified herein.
 1. Peastone gravel
 2. Stone dust surfacing
- B. Samples: Design reference samples for initial verification of peastone gravel and stone dust material.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver peastone gravel to project site at such times to assure continuity of installation. Store material at project site to prevent theft, vandalism, deterioration, distortion or other physical damage.

1.7 JOB CONDITIONS

- A. Field Measurements: Verify layout information for steel metal landscape header, shown on the Drawings. Verify dimensions by field layout.

PART 2 - PRODUCTS

2.1 PEASTONE

- A. Peastone shall be 1/4" inch minus rounded, durable stone of uniform quality, free from loam and clay and meeting the following sieve gradation analysis by weight:

<u>Sieve Size</u>	<u>% Passing by Weight</u>
1/2 in.	100
3/8 in.	85-100
No. 4	0-15
No. 8	0-5

- B. The peastone shall be cleaned and washed before use, with not more than 0.5 percent of material passing a No. 200 sieve. The peastone shall be free from dust, clay, soot from burner

fuel, or any other deleterious substances. It shall also be essentially dry, with a water content less than 0.5 percent as determined by AASHTO T142.

2.2 STONE DUST

- A. Stone dust shall be provided for walking trail as shown on the Drawings. Stone dust shall consist of crushed granite screenings, consisting of clean, hard, durable, uncoated particles of granite quartz, materials shall be free from dirt, clay, organic matter, flaky material, excess fines or other deleterious materials. Stone dust screenings shall be the product of a secondary crusher or, if primary crusher screenings are to be used, they shall be reprocessed in a manner to produce a satisfactory material.
 - 1. Provide stone dust screenings meeting the gradation requirements of ASTM C 448, Size No. 10
- B. Provide 3 lb. sample of stone dust conforming to this specification for inspection and approval by the Architect prior to the commencement of installation.

2.3 WEED CONTROL FABRIC

- A. Weed control fabric shall be a needle punched non-woven polypropylene fabric having the following properties as required minimums:
 - 1. Weight of 3.5 oz./sq.yd.
 - 2. Tensile strength of 115 lb. per ASTM D 4632.
 - 3. Equivalent opening size (EOS) no larger than U.S. Standard Sieve Size 50.
 - 4. Water Flow Rate: 182 gal./min./s.f.
- B. Acceptable manufacturers include Mirafi, Inc., Charlotte, NC 28224, Phillips Fibers Corp., Greenville, SC; and DuPont Co., Wilmington, DE.

2.4 STEEL EDGING AND STAKES

- A. Steel edging shall be Border Concepts Edging, "Border Guard", manufactured by Border Concepts, Inc., P.O. Box 471185, Charlotte, NC 28247 or approved equal. Steel edging shall be shop fabricated, 3/16 in. thick x 3 1/2 in. deep, primed and painted black. Edging shall be furnished in 4-16 ft. lengths.
 - 1. Steel edging shall have slotted holes for staking steel edging every 30 in. on center.
 - 2. Steel stakes shall be 15 in. long, tapered.
 - 3. Provide manufacturer's end stake and splicer unit.
 - 4. Provide manufacturer's standard touch-up paint for field touch-up of scratched or marred areas.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install and construct products and items specified in PART 2 of this Section in strict compliance with manufacturer's specifications and recommendations unless otherwise specified herein.

- B. Coordinate work with subgrade base preparation and backfilling operations.
- C. Protect, support and brace all site improvements as necessary during construction until ready for use.
- D. FINISHED GRADE: Do not begin installations and erection before the finish elevations have been established, unless otherwise permitted.

3.2 PEASTONE DRIP STRIP INSTALLATION

- A. Perform fine grading, filling, and compaction of subgrade to receive peastone surfacing, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be done under this Section.
- B. existing subgrade material which will not readily compact as required, shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be gravel borrow conforming to Section 312300 – EARTHWORK FOR SITE.
- C. Subgrade of areas to be surfaced with peastone shall be undisturbed or shall be compacted as required to bring top 6 in. of material immediately below peastone surface course to a compaction of at least 90% of maximum density, as determined by ASTM D 1557, Method D.
- D. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 in. deep in subgrade, shall be graded out, reshaped as required, and re-compacted before placing peastone surface.
- E. Materials shall not be stored or stockpiled on subgrade.
- F. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section shall be legally disposed of off-site or as otherwise directed by the Owner.
- G. Prepared subgrade will be inspected and approved by the Architect before installation of steel edging and peastone surface course. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the specification.
- H. Install edging before spreading peastone surfacing. Install edging as shown in the details in the locations indicated. Edging shall be installed straight, true, and plumb, with a straight top line, installed to a top height of 1 inch above peastone finish grade or as shown on the details. Corners of edging shall be tight, neat and level.
- I. Placing and compacting of peastone surface shall be as nearly a continuous process as possible. Compacting shall begin as soon after placing peastone as possible. Corrections required in surface shall be made by removing or adding materials before compacting is completed. Displacement of peastone or other fault shall be corrected at once by use of rakes and application of additional peastone, as required. Depth shown on the details is compacted depth.
- J. In places not accessible to roller, peastone shall be compacted with hand tampers. Hand tampers shall weigh at least 50 lb. and shall have a tamping face less than or equal to 100 sq. in.

Mechanical tampers capable of equal compaction will be acceptable in areas in which they can be employed effectively.

- K. Variations in smoothness of finished surface shall be less than or equal to the following tolerances when tested with a 10 ft. straightedge.
 - 1. For peastone surface course - 1/2 in. in 10 ft.
 - 2. Irregularities exceeding these amounts shall be corrected by hand raking to level surface or removing defective work, replacing with new material and compact in conformance to this Section.

3.3 STONE DUST SURFACING

- A. Install stone dust trail as shown on the Drawings and in the Details.
- B. Perform fine grading, filling, and compaction of subgrade to receive stone dust trail, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines.
- C. Existing subgrade material which will not readily compact as required, shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be gravel borrow conforming to Section 02220 – EXCAVATION, BACKFILL & COMPACTION. Construction methods not more specifically specified herein shall conform to the applicable paragraphs of Sections 303 and 305 of the R.I. D.O.T Standard Specifications.
- D. Subgrade of areas to be surfaced with stone dust shall be undisturbed or shall be compacted as required to bring material immediately below stone dust surface course to a compaction of at least 90% of maximum density, as determined by ASTM D 1557, Method D.
- E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 in. deep in subgrade, shall be graded out, reshaped as required, and re-compacted before placing stone dust surface.
- F. Materials shall not be stored or stockpiled on subgrade.
- G. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section shall conform to the following:
 - 1. Material shall be legally disposed of off-site or as otherwise directed by the Owner.
- H. Prepared subgrade will be inspected and approved by the Architect before installation of steel edging and stone dust surface course. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the specification.
- I. Install edging and weed control fabric before spreading stone dust surfacing. Install edging as shown in the details in the locations indicated. Edging shall be installed straight, true, and plumb, with a straight top line, installed flush with the finish surface of the stone dust finish grade. Curved segments shall exhibit a graceful alignment with constant radius curves and without “broken back” curves. Weed control fabric shall extend 4” up the inside of the edging.

- J. Placing and compacting of stone dust surface shall be as nearly a continuous process as possible. Compacting shall begin as soon after placing stone dust as possible. Corrections required in surface shall be made by removing or adding materials before compacting is completed. Displacement of stone dust or other fault shall be corrected at once by use of rakes and application of additional stone dust, as required. Depth shown on the details is compacted depth.
- K. Stone dust shall be compacted with hand tampers. Hand tampers shall weigh at least 50 lb. and shall have a tamping face less than or equal to 100 sq. in. Mechanical tampers capable of equal compaction will be acceptable in areas in which they can be employed effectively.
- L. Variations in smoothness of finished surface shall be less than or equal to the following tolerances when tested with a 10 ft. straightedge. For stone dust surface course - 1/2 in. in 10 ft. Irregularities exceeding these amounts shall be corrected by hand raking to level surface or removing defective work, replacing with new material and compact in conformance to this Section.

3.4 SAND SURFACE AT PLAYGROUND

- A. Perform fine grading, filling, and leveling of existing sand playground surface to receive new sand surface, as required to form a firm, uniform, level subgrade at required elevations and to required lines.
- B. Playground areas being graded shall be kept shaped and drained during construction. Ruts greater than or equal to 2 in. deep in subgrade, shall be graded out and filled as required, before placing sand surface.
- C. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section shall be legally disposed of off-site or as otherwise directed by the Architect.
- D. Prepared subgrade will be inspected and approved by the Architect before installation of steel edging and sand surface course. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the specification.
- E. Install wood edging before spreading sand surfacing. Install edging as shown in the details in the locations indicated. Edging shall be installed straight, true, and plumb, with a straight top line. Edging shall be installed such that final compacted surface of the sand shall be 1" below the top of the edging. Top of the edging shall be flush with the surface of the adjacent lawn. Corners of edging shall be tight, neat and level.
- F. Placing and compacting of sand surface shall be as nearly a continuous process as possible. Compacting shall begin as soon after placing sand as possible. Corrections required in surface shall be made by removing or adding materials before compacting is completed. Displacement of sand or other fault shall be corrected at once by use of rakes and application of additional sand, as required. Depth shown on the details is compacted depth.

3.5 CLEAN-UP

- A. The Contractor shall remove from the site all debris, equipment and scrap material appurtenant to peastone surface work.

END OF SECTION 321843

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SECTION 323119 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Decorative steel fences.
 - 2. Swing gates.
 - 3. Gate operators, including controls.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for concrete post concrete fill.
 - 2. Section 281300 "Access Control" for access control devices installed at gates and provided as part of a security system.

1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at the proposed neighborhood center to be constructed at 1342 Congress Street in Portland, Maine.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include diagrams for power, signal, and control wiring.
- C. Samples: For each fence material and for each color specified.
 - 1. Provide Samples 12 inches in length for linear materials.
 - 2. Provide Samples 12 inches square for bar grating and sheet plate materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For gate operators to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Include 6-foot length of fence complying with requirements.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 DECORATIVE STEEL FENCE

- A. Decorative Steel Fences: Fences made from steel tubing and shapes.
- B. Posts: Square steel tubing.
 - 1. Line Posts: 2 by 2 inches with 1/8-inch wall thickness.
 - 2. End and Corner Posts: 2-1/2 by 2-1/2 inches with 3/16-inch wall thickness.
 - 3. Swing Gate Posts: 3 by 3 inches with 3/16-inch wall thickness.
- C. Post Caps: Formed from steel sheet and hot-dip galvanized after forming] [Aluminum castings.
- D. Rails:
 - 1. Steel Tube Rails: Square steel tubing 2 by 2 inches with wall thickness.
- E. Pickets: 3/4-inch square steel tubes.
 - 1. Terminate tops of pickets at top rail for flush top appearance.
 - 2. Picket Spacing: 3-3/4 inches clear, maximum.
 - 3. Treillage: Provide iron castings of pattern indicated between each pair of pickets.
- F. Infill Ring Adornment: Custom design as indicated on Drawings.
 - 1. Ring: 3/4-inch square steel bar rounded into ring to size as to fit snug between two top rails.
- G. Fasteners: Stainless-steel carriage bolts and tamperproof nuts.
- H. Fabrication: Assemble fences into sections by welding pickets to rails.
 - 1. Fabricate sections with clips welded to rails for field fastening to posts.
 - 2. Drill posts and clips for fasteners before finishing to maximum extent possible.

- I. Fabrication: Fabricate bar grating infill into sections of size indicated.
 - 1. Fabricate rails with clips welded to rails for field fastening to posts.
 - 2. Drill posts, clips, and bar grating for fasteners before finishing to maximum extent possible.
- J. Finish exposed welds to comply with NOMMA Guideline 1: Finish - partially dressed weld with splatter removed and minimal pinholes.
- K. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
 - 1. Hot-dip galvanize posts and rails.
 - 2. Hot-dip galvanize rail and picket assemblies after fabrication.
 - 3. Hot-dip galvanize bar grating infill after fabrication.
 - 4. Hot-dip galvanize custom-design rail and infill assemblies after fabrication.
- L. Finish for Steel Items: Shop primed and painted with high performance.
- M. Color: Black as selected by Architect.

2.3 DECORATIVE STEEL SWING GATES

- A. Gate Configuration: Single leaf.
- B. Gate Frame Height: As indicated on Drawings.
- C. Gate Opening Width: As indicated on Drawings.
- D. Steel Frames and Bracing: Fabricate members from square steel tubing 1-1/2 by 1-1/2 with 14 gauge wall thickness. Hot-dip galvanize frames after fabrication.
- E. Frame Corner Construction: Welded and 5/16-inch-diameter, adjustable truss rods for gate leaf 5 feet wide or wider.
- F. Additional Rails: Provide as indicated, complying with requirements for fence rails.
- G. Infill: Comply with requirements for adjacent fence.
- H. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
- I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
- J. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
 - 1. Function: 39 - Full surface, triple weight, antifriction bearing.
 - 2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.
- K. Rim and or Mortise Locks: As specified by the Architect.

- L. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push pad actuating bar, suitable for exterior use. As specified by the Architect.
- M. Finish exposed welds to comply with NOMMA Guideline 1, Finish - partially dressed weld with splatter removed and some pinholes okay.
- N. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
- O. Steel Finish: Shop painted.

2.4 STEEL AND IRON

- A. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
- C. Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- D. Bar Grating: NAAMM MBG 531.
 - 1. Bars: Hot-rolled steel strip, ASTM A 1011/A 1011M, Commercial Steel, Type B.

2.5 COATING MATERIALS

- A. Shop Primer for Steel: Manufacturer's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Epoxy Zinc-Rich Primer for Uncoated Steel: Complying with MPI #20 and compatible with coating specified to be applied over it.
- C. Epoxy Primer for Galvanized Steel: Epoxy primer recommended in writing by topcoat manufacturer.
- D. Epoxy Intermediate Coat for Uncoated Steel: Complying with MPI #77 and compatible with primer and topcoat.
- E. Intermediate Coat for Uncoated Steel: Epoxy or polyurethane intermediate recommended in writing by primer and topcoat manufacturer.
- F. Polyurethane Intermediate Coat and Topcoat: Complying with MPI #72 and compatible with undercoat.

2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 - 1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch lump, and 3/4-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions.
- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.7 STEEL FINISHES

- A. Surface Preparation: Clean surfaces according to SSPC-SP 5/NACE No. 1, White Metal Blast Cleaning
 - 1. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.
- B. Powder Coating: Immediately after cleaning, apply two-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils. Comply with coating manufacturer's written instructions.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.
- C. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that are exposed after assembly and installation, and to concealed surfaces.
- D. Shop-Painted Finish: Comply with Section 099600 "High-Performance Coatings."
- E. High-Performance Coating: Apply intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
 - 1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 400 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
 - 1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Install fences by setting posts as indicated and fastening infill panels to posts. Peen threads of bolts after assembly to prevent removal.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 36 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.
- D. Post Setting: Set posts as indicated on Drawings.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Concealed Concrete: Top 2 inches below grade as indicated on Drawings to allow covering with surface material. Slope top surface of concrete to drain water away from post.
 - 3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
 - 4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.
 - a. Extend posts at least 5 inches into sleeve.
 - b. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.
 - 5. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch larger than outside diagonal dimension of post.
 - a. Extend posts at least 5 inches into concrete.
 - b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.
 - 6. Space posts uniformly at 8 feet o.c.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means.

Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 GATE OPERATOR INSTALLATION

- A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Excavation for concrete Bases: Hand-excavate holes for bases in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated.
- C. Concrete Bases: Cast-in-place or precast concrete, Depth not less than 36 inches, dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.
- D. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - 1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
 - 2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
 - 3. Report: Prepare test reports of grounding resistance at each test location certified by a testing agency. Include observations of weather and other phenomena that may affect test results.

3.7 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Automatic Gate Operators: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, and limit switches.
 - 1. Hydraulic Operators: Purge operating system, adjust pressure and fluid levels, and check for leaks.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls, alarms, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lubricate hardware, gate operators, and other moving parts.

END OF SECTION 323119

SECTION 329115 - SOIL PREPARATION (PERFORMANCE SPECIFICATION)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes planting soils and layered soil assemblies specified according to performance requirements of the mixes.
- B. Related Requirements:
 - 1. Section 129300 "Site Furnishings" for placing planting soil in exterior unit planters.
 - 2. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
 - 3. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
 - 4. Section 329300 "Plants" for placing planting soil for plantings.

1.3 ALLOWANCES

- A. Preconstruction and field quality-control testing are part of testing and inspecting allowance.

1.4 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1.5 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.

- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- M. SSSA: Soil Science Society of America.
- N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- Q. USCC: U.S. Composting Council.

1.6 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at the proposed neighborhood center to be constructed at 1342 Congress Street in Portland, Maine.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include recommendations for application and use.
 2. Include test data substantiating that products comply with requirements.
 3. Include sieve analyses for aggregate materials.
 4. Material Certificates: For each type of imported soil, soil amendment and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.

- b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
 - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- C. Field quality-control reports.

1.9 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
 - 1. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.10 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.
 - 1. Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
 - 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.11 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Landscape Architect under the direction of the testing agency.
 - 1. Number and Location of Samples: Minimum of five representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.

2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.12 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
 1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
 2. Bulk Density: Analysis according to core method and clod method of SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 3. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 4. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 5. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85 percent compaction according to ASTM D 698 (Standard Proctor).
- C. Chemical Testing:
 1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
 2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
 4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
- D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol including the following:
 1. Percentage of organic matter.
 2. CEC, calcium percent of CEC, and magnesium percent of CEC.
 3. Soil reaction (acidity/alkalinity pH value).
 4. Buffered acidity or alkalinity.
 5. Nitrogen ppm.
 6. Phosphorous ppm.
 7. Potassium ppm.

8. Manganese ppm.
 9. Manganese-availability ppm.
 10. Zinc ppm.
 11. Zinc availability ppm.
 12. Copper ppm.
 13. Sodium ppm and sodium absorption ratio.
 14. Soluble-salts ppm.
 15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 16. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Do not move or handle materials when they are wet or frozen.
 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

- A. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained and stockpiled on-site; modified, if necessary, to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site

surface soil to become planting soil complying with USDA and American Nursery and Landscape Association requirements.

- B. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of soil modified, if necessary, to produce viable planting soil according to USDA textures. Amend imported soil with materials specified in other articles of this Section to become planting soil complying with USDA and American Nursery and Landscape Association requirements.
 - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass.
 - 2. Additional Properties of Imported Soil before Amending: Minimum of 10 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration. Clean soil to be free of the following:
 - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 10 percent by dry weight of the imported soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
 - 2. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
 - 3. Form: Provide lime in form of ground dolomitic limestone.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- E. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
 - 1. Feedstock: Limited to leaves.
 - 2. Reaction: pH of 5.5 to 8.
 - 3. Soluble-Salt Concentration: Less than 4 dS/m.
 - 4. Moisture Content: 35 to 55 percent by weight.
 - 5. Organic-Matter Content: 40 to 50 percent of dry weight.
 - 6. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum five dS/m.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum five dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- D. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
 - 1. Partially Decomposed Wood Derivatives: In lieu of shredded and composted wood derivatives, mix shredded and partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. of loose sawdust or ground bark.
- E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 50 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

- D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a combined maximum of 10 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 8 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
- C. Mixing: Spread unamended soil to total depth of 6 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
 - a. Mix lime and sulfur with dry soil before mixing fertilizer.
 - b. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 80 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.
 - E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 8 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
- C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 1. Lifts: Apply planting soil in lifts not exceeding 6 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 80 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 BLENDING PLANTING SOIL IN PLACE

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Preparation: Till unamended, existing soil in planting areas to a minimum depth 8 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
 1. Mix lime and sulfur with dry soil before mixing fertilizer.
 2. Mix fertilizer with planting soil no more than seven days before planting.

- D. Compaction: Compact blended planting soil to 80 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

- A. Application: Apply compost component of planting-soil mix 4 inches of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests:
 - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
 - 2. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
 - 3. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution Requirements" for requirements for correcting the Work.
- C. Soil will be considered defective if it does not pass tests.
- D. Prepare test reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.8 PROTECTION

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.
 - 4. Foot traffic.

5. Erection of sheds or structures.
 6. Impoundment of water.
 7. Excavation or other digging unless otherwise indicated.
- C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.9 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329115

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SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Hydroseeding.
 - 3. Sodding.
 - 4. Plugging.
 - 5. Sprigging.
 - 6. Meadow grasses and wildflowers.
 - 7. Turf renovation.
 - 8. Erosion-control material(s).
 - 9. Grass paving.
- B. Related Requirements:
 - 1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
 - 2.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at the proposed neighborhood center to be constructed at 1342 Congress Street in Portland, Maine.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for turf grass and sod. Include identification of source and name and telephone number of supplier.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor or person assigned to perform the role of field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawncare Manager.
 - c. Landscape Industry Certified Lawncare Technician.
 - 5. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
 - 1. Spring Planting: No earlier than March 31st.
 - 2. Fall Planting: No later than November 31st.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
 - 1. Quality: State-certified seed of grass species as listed below for solar exposure.
 - 2. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed.
 - 3. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 - 4. Sun with Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 40 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Approved turfgrass sod complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of

uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

- B. Turfgrass Species: Kentucky Bluegrass with Creeping Red Fescue.
- C. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Full Sun: 50% - 100% Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars with 0%-30% Fine Fescue (minimum of three cultivars) and 0%-25% Perennial Ryegrass.
 - 2. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 60 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent fine fescue.
 - c. 10 percent Perennial Ryegrass (*Lolium perenne*).

2.3 WETLAND MIX

- A. Wetland Seed Mix: Fresh, clean, and dry new seed, of mixed species as follows:
 - 1. Fox Sedge, (*Carex vulpinoidea*), Lurid Sedge, (*Carex lurida*), Blunt Broom Sedge, (*Carex scoparia*), Sensitive Fern, (*Onoclea sensibilis*), Blue Vervain, (*Verbena hastata*), Hop Sedge, (*Carex lupulina*), Green Bulrush, (*Scirpus atrovirens*), Nodding Bur Marigold, (*Bidens cer-nua*), Bristly Sedge, (*Carex comosa*), Fringed Sedge, (*Carex crinita*), American Mannagrass, (*Glyceria grandis*), Wool Grass, (*Scirpus cyperinus*), Soft Rush, (*Juncus effusus*), Spotted Joe Pye Weed, (*Eupatorium maculatum*), Boneset, (*Eupatorium perfoliatum*), Mud Plantain, (*Alisma subcordatum*), New England Aster, (*Aster novae-angliae*), Rattlesnake Grass, (*Glyceria canadensis*), Purplestem aster (*Aster puniceus*), Soft Stem Bulrush, (*Scirpus validus*), Blueflag (*Iris versicolor*), Swamp Milkweed, (*Asclepias incarnata*), Monkey Flower, (*Mimulus ringens*).

2.4 FERN SOD

- A. Fern Sod: Sod consisting of native fern species.
- B. Fern Species: Fern sod shall consist of the following species;
 - 1. Hayscented Fern (*Dennstaedtia punctilobula*); New York Fern (*Thelypteris noveboracensis*); Christmas Fern (*Polystichum acrostichoides*); Cinnamon Ferns (*Osumda cinnamomea*); Interrupted Ferns (*Osumda claytoniana*); Ostrich Ferns (*Matteuccia stuthiopteris*).

2.5 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.6 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.7 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.8 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from overspray from hydroseed and hydromulch operations.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation"
- B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade
 - 1. Reduce elevation of planting soil area to allow for soil thickness of sod.
- C. Moistened prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.

- B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 4 to 6 lbs/1000 sq. ft.
- C. Rake seed lightly into top 1/4 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

3.6 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
 - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 SODDING

- A. Lay sod within 24 hours of harvest. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 TURF RENOVATION

- A. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 2. Install new planting soil as required.
- B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- C. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- D. Mow, dethatch, core aerate, and rake existing turf.
- E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- H. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
- I. Apply turf seed and/or hydroseed and protect with straw mulch as required for new turf.
- J. Water newly planted areas and keep moist until new turf is established.

3.9 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
 - C. Mow turf as soon as top growth is of adequate height to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 1. Mow Kentucky bluegrass, annual ryegrass and chewings red fescue to a height of 1-1/2 to 2 inches.
 - D. Turf Post-cut fertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.
 1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.10 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Landscape Architect:
 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding an area 5 by 5 inches in size.
 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
 3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
 4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.11 WETLAND MIX

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

2. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow seed at a total rate of 1 lbs./2500 sq. ft.
 - C. Brush seed into top 1/4 inch of soil, roll lightly, and water with fine spray.
 - D. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 1/4 inch, and roll surface smooth.
 - E. Water newly planted areas and keep moist until meadow is established.

3.12 WETLAND MAINTENANCE

- A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.
 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water meadow with fine spray at a minimum rate of 1/2 inch per week for six weeks after planting unless rainfall precipitation is adequate.

3.13 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.14 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.15 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
 - 1. Seeded Turf: 90 days from date of Substantial Completion determination.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
 - 2. Sodded Turf: 60 days from date of Substantial Completion determination.
- B. Wetland Seed Mix Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Begin maintenance immediately after each area is planted and continue until established, but for not less than maintenance period below.
 - 1. Maintenance Period: 60 days from date of Substantial Completion.

END OF SECTION 329200

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SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Plants.
 - 2. Tree stabilization.
 - 3. Tree-watering devices.
 - 4. Landscape edgings.
- B. Related Requirements:
 - 1. Section 029550 "Site Preparation/Tree Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
 - 2. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
- B. Unit prices apply to authorized work covered by quantity allowances.
- C. Unit prices apply to additions to and deletions from the Work as authorized by Change Orders.

1.4 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Ball and Burlap Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than sizes indicated with container size recommended by ANSI Z60.1 for type and size of plant required.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- J. Planting Area: Areas to be planted.
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. Soil Preparation (Performance Specification) for drawing designations for planting soils.
- L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.5 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.6 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at the proposed neighborhood center to be constructed at 1342 Congress Street in Portland, Maine.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 10 plants are required, include a minimum of four photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
- B. Samples for Verification: For each of the following:
 - 1. Trees and Shrubs: Two samples of each variety and size to be delivered to the site for review and approval. These samples shall be designated as the control samples and maintained and installed on-site as the standard for comparison.
 - 2. Organic Composted Mulch: One-quart size volume of each organic mulch type is required; in sealed plastic container labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 - 3. Stone Mulch: 2 lbs. of each mineral mulch required, in sealed plastic container labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on-site; provide an accurate indication of color, texture, and makeup of the material.
 - 4. Weed Control Barrier: 12 by 12 inch square labeled with name of manufacturer.
 - 5. Proprietary Root-Ball-Stabilization Device: One unit.
 - 6. Slow-Release, Tree-Watering Device: One unit of each size required.
 - 7. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis of standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

1.9 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years of experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor or person assigned to perform the role of field supervisor by the landscape installer shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Interior.
 - c. Landscape Industry Certified Horticultural Technician.
 - 5. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
 - 1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 12 inches above the root flare for trees up to 4-inch caliper size, and 18 inches above the root flare for larger sizes.
 - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 - 1. Notify Landscape Architect of sources of planting materials two in advance of delivery to site.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Deliver bare-root stock plants within 48 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- E. Handle planting stock by root ball.
- F. Store bulbs, corms, and tubers in a dry place at 60 to 65 degrees Fahrenheit until planting.
- G. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
1. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.
- H. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 3. Do not remove container-grown stock from containers before time of planting.
 4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.12 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
1. Spring Planting: Trees - March 1st through May 31st.

2. Shrubs and Groundcovers – March 1st thru November 31st.
3. Fall Planting: Trees – September 1st through November 31st.
4. Shrubs and Groundcovers - March 1st thru November 31st .

- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.13 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of planting, tree stabilization, and edging.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Periods: From date of plant material installation determined by Landscape Architect as substantially complete.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: Twelve (12) months.
 - b. Ground Covers, Biennials, Perennials, and Other Plants Twelve (12) months.
 - c. Annuals: Two months.
 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
 - C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
 - D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
 - E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
 - F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and in bud but not yet in bloom.

2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 1. Size: 10-gram tablets.
 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 1. Type: Shredded bark mulch shall be a natural forest product of 98% bark and contain less than two percent (2%) wood or other debris. It shall be of white or red fir and / or Pine bark of a uniform grade without additives or any other treatment.
 2. Size Range: From 5/8" minimum to 1-1/4" maximum.
 3. Color: Natural.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 1. Organic Matter Content: 10 to 20 percent of dry weight.
 2. Feedstock that may be present in organic mulch matter: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

- C. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:
 - 1. Type: Rounded riverbed gravel or smooth-faced stone
 - 2. Size Range: 1/2 inch minimum to 1-1/2 inch maximum.
 - 3. Color: Readily available natural gravel with color range acceptable to Landscape Architect.

2.4 WEED-CONTROL BARRIERS

- A. Nonwoven Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.
- B. Woven Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.0 oz./sq. yd..

2.5 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 - 1. Upright Poles and Guy Stakes: Rough-sawn, sound, new kiln dried hardwood treated with preservative to inhibit decay and repel insects, free of knots, holes, cross grain, and other defects, 3-inch nominal diameter by 8' length, pointed at one end.
 - 2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.
 - 3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 3/16-inch in diameter.
 - 4. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
 - 5. Guy Cables: Five-strand, 3/16-inch-diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of three inches long, with two 3/8-inch galvanized eyebolts.
 - 6. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
- B. Root-Ball Stabilization Materials:
 - 1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length required; stakes pointed at one end.
 - 2. Wood Screws: ASME B18.6.1.

3. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-4-inch nominal by lengths indicated.
4. Straps: Adjustable steel or plastic package banding.
5. Padding: Burlap.

2.7 LANDSCAPE EDGING

- A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
 1. Edging Size: 3/16-inch-thick by 4 inches (100 mm) tall.
 2. Stakes: Tapered steel, a minimum of 12 inches long.
 3. Accessories: Standard tapered ends, corners, and splicers.
 4. Finish: Manufacturer's standard paint] finish.
 - a. Paint Color: Black.
- B. Aluminum Edging: Standard-profile extruded-aluminum edging, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
 1. Edging Size: 3/16 inch thick by 5-1/2 inch deep.
 2. Stakes: Aluminum, per manufacturer's system.
 3. Finish: Black anodized.
- C. Plastic Edging: Standard black polyethylene or vinyl edging, round top bead and v-lipped bottom, extruded in standard lengths, with 9-inch steel angle stakes.
 1. Edging Size: 0.075 inch thickness by 5 inches deep.
 2. Top Profile: Straight, with top 2 inches being 1/4 inch thick.
 3. Top Profile: Round top, 1 inch in diameter.
 4. Accessories: Manufacturer's standard alignment clips or plugs.

2.8 TREE-WATERING DEVICES

- A. Watering Pipe: PVC pipe 4 inches in diameter, site-cut to length as required, and with snug-fitting removable cap.
- B. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
 1. Color: As selected by Landscape Architect from manufacturer's full range.

2.9 MISCELLANEOUS PRODUCTS

- A. Wood Pressure-Preservative Treatment: AWP A U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

- C. Burlap: Non-synthetic, biodegradable.
- D. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- E. Planter Filter Fabric: Woven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.
- F. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- D. Application of Mycorrhizal Fungi: At time directed by Landscape Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
 - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - 2. Excavate approximately three times as wide as ball diameter for ball and burlap stock.
 - 3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
 - 4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 - 5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - 6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 - 7. Maintain supervision of excavations during working hours.
 - 8. Keep excavations covered or otherwise protected after working hours when left unattended by Installer's personnel.
 - 9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated. Amend soil as needed to meet specification requirements.
- C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
 - 1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Ball and Burlap Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above finished grade for trees and 1 inch above adjacent finish grade for shrubs.
 - 1. Backfill: Planting soil for trees may consist of excavated soil for backfill if amended to meet planting soil specifications.
 - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: Two per each caliper inch of tree.
 - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Ball and Potted, Container-Grown and Bare Root Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above finish grades.
 - 1. Backfill: Planting soil for ball and potted and container grown stock may consist of excavated soil for backfill if amended to meet planting soil specifications.
 - 2. Carefully remove root ball from container without damaging root ball or plant.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: Two per plant.
 - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

- A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlap root-ball diameter according to ANSI Z60.1, or larger than

manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

- B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.
- C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- D. Cut exposed roots cleanly during transplanting operations.
- E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.
- F. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
 - 1. Upright Staking and Tying: Stake trees of 2-1/2" caliper or greater. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension of at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
 - 2. Upright Staking and Tying: Stake trees with one stake for trees up to 12 feet high and 2-1/2 inches or less in caliper.
 - 3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
 - 4. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
- B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 feet in height and more than 3 inches in caliper unless otherwise indicated.
 - 1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

- a. Securely attach guys to stakes 30 inches long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle for each guy wire and tighten securely.
 - b. For trees more than 6 inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle for each guy wire and tighten securely.
 - c. Support trees with guy cable, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
 - d. Paint turnbuckles with luminescent white paint.
2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
- C. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
- 1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.
 - a. Install stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation. Saw stakes off at horizontal stake.
 - b. Install screws through horizontal hold-down and penetrating at least 1 inch into stakes. Predrill holes if necessary to prevent splitting wood.
 - c. Install second set of stakes on other side of root trunk for larger trees.
 - 2. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
- D. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.
- 1. Site-Fabricated Palm-Bracing Method:
 - a. Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact trunk.
 - b. Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.
 - 2. Proprietary Palm-Bracing Device: Install palm-bracing system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.9 ROOT-BARRIER INSTALLATION

- A. Install root barrier where trees are planted within 48 inches of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.
- B. Align root barrier vertically, and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.

3.10 PLACING SOIL IN PLANTERS

- A. Place a layer of drainage gravel at least 4 inches thick in bottom of raised planters. Cover bottom with filter fabric and wrap filter fabric 6 inches up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.
- B. Fill planter with planting soil. Place soil in lightly compacted layers to an elevation of 1-1/2 inches below top of planter, allowing natural settlement.

3.11 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.12 PLANTING AREA MULCHING

- A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.
- B. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. For trees and shrubs (with tree-like form and growth) to be planted in turf Areas: Apply organic mulch ring of 2-inch average thickness, with 24-inch radius around trunks or stems. Do not place mulch within 6 inches of trunks or stems.
 - 2. Organic Mulch in Planting Areas: Apply 1-inch average thickness of organic mulch over whole surface of planting area and extend 6 inches beyond edge of individual planting pit or trench, and finish level with adjacent finish grades. Do not place organic mulch within 6 inches of trunks or stems.

3.13 EDGING INSTALLATION

- A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced apart per manufacture's requirements driven below top elevation of edging.

- B. Aluminum Edging: Install aluminum edging where indicated according to manufacturer's written instructions. Anchor with aluminum stakes spaced apart per manufacturer's requirements driven below top elevation of edging.
- C. Shovel-Cut Edging: Separate mulched areas from turf areas with a 45-degree, 4- to 6-inch-deep, shovel-cut edge as indicated on Drawings.

3.14 INSTALLING SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.15 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.16 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.17 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
 1. Submit details of proposed pruning and repairs.
 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

- B. Remove and replace trees that are more than **25** percent dead or in an unhealthy condition as agreed **before the end of the corrections period** or are damaged during construction operations that the Landscape Architect determines are incapable of restoring to normal growth pattern.
 - 1. Provide new plant material of same size and species as plant material being replaced.

3.18 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and prior to determination of Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.19 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period: Twelve months from date of Substantial Completion.
- B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period: Twelve months from date of Substantial Completion

END OF SECTION 329300

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