PROJECT MANUAL – DESIGN DEVELOPMENT

Eastport Health Care Community Health Center

Eastport, Maine

Architect Project No: **10310.001**

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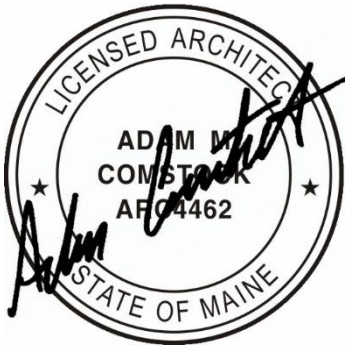
1.1 DESIGN PROFESSIONALS OF RECORD

ARCHITECT	Adam M. Comstock, AIA	
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END OF DOCUMENT 00 01 07

SECTION 01 10 00 - SUMMARY

PART 1 GENERAL

1.1 PROJECT

A. Project Name: [____]New Community Health Center.

B. Owner's Name: Eastport Health Care Inc..

C. Architect's Name: WBRC Inc.

D. Additional Project contact information is specified in Section 00 01 03 - Project Directory.

E. The Project consists of the construction of _____.

1.2 CONTRACT DESCRIPTION

1.3 OWNER OCCUPANCY

A. Owner intends to occupy the Project upon Substantial Completion.

B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

C. Schedule the Work to accommodate Owner occupancy.

END OF SECTION 01 10 00

SECTION 01 21 00 - ALLOWANCES

PART 1 GENERAL

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 21 00

SECTION 01 22 00 - UNIT PRICES

PART 1 GENERAL

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 22 00

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

2.1 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
2. Agrees to provide the same warranty for the substitution as for the specified product.
3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
4. Waives claims for additional costs or time extension that may subsequently become apparent.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.

C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.

D. Limit each request to a single proposed substitution item.

2.2 RESOLUTION

2.3 ACCEPTANCE

END OF SECTION 01 25 00

SECTION 01 31 14 - FACILITY SERVICES COORDINATION

PART 1 GENERAL

1.1 MECHANICAL AND ELECTRICAL COORDINATOR

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 COORDINATION REQUIRED

3.2 OBSERVATION OF WORK

3.3 EQUIPMENT START-UP

END OF SECTION 01 31 14

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 3 EXECUTION

1.1 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.

D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

1.2 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not complying with specified requirements.

END OF SECTION 01 40 00

SECTION 01 42 19 - REFERENCE STANDARDS

END OF SECTION 01 42 19

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 50 00

SECTION 01 57 13 - TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.2 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

END OF SECTION 01 57 13

SECTION 01 57 23 - TEMPORARY STORM WATER POLLUTION CONTROL

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.

1.2 SUMMARY

A. Section Includes:

1. Temporary stormwater pollution controls.

1.3 STORMWATER POLLUTION PREVENTION PLAN

A. The Stormwater Pollution Prevention Plan (SWPPP) is part of the Contract Documents and is bound into this Project Manual.

B. The project is subject to permitting through the Maine Department of Environmental Protection’s (MaineDEP’s) Maine Construction General Permit (MCGP) and Stormwater Management Law (Stormwater Permit). Erosion and sedimentation control for this project will be pursuant to the most recent best management practices, laws, rules, and regulations established through the MaineDEP and the City of Eastport.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, and earthwork subcontractor.
2. Review requirements of the SWPPP, including permitting process, worker training, and inspection and maintenance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Stormwater Pollution Prevention Plan (SWPPP): Within 15 days of date established for commencement of the Work, submit completed SWPPP.

B. EPA authorization under the EPA's "2017 Construction General Permit (CGP)."

C. Stormwater Pollution Prevention (SWPP) Training Log: For each individual performing Work under the SWPPP.

D. Inspection reports.

1.6 QUALITY ASSURANCE

A. Stormwater Pollution Prevention Plan (SWPPP) Coordinator: Experienced individual or firm with a record of successful water pollution control management coordination of projects with similar requirements.

1. SWPPP Coordinator shall complete and finalize the SWPPP form.
2. SWPPP Coordinator shall be responsible for inspections and maintaining of all requirements of the SWPPP.

B. Installers: Trained as indicated in the SWPPP.

PART 2 PRODUCTS

2.1 TEMPORARY STORMWATER POLLUTION CONTROLS

A. Provide temporary stormwater pollution controls as required by the SWPPP.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with all best management practices, general requirements, performance requirements, reporting requirements, and all other requirements included in the SWPPP.

B. Locate stormwater pollution controls in accordance with the SWPPP.

C. Conduct construction as required to comply with the SWPPP and minimize possible contamination or pollution or other undesirable effects.

1. Inspect, repair, and maintain SWPPP controls during construction.

a. Inspect all SWPPP controls not less than every seven days, and after each occurrence of a storm event, as outlined in the SWPPP.

D. Remove SWPPP controls at completion of construction and restore and stabilize areas disturbed during construction.

END OF SECTION 01 57 23

SECTION 01 58 13 - TEMPORARY PROJECT SIGNAGE

PART 2 PRODUCTS

END OF SECTION 01 58 13

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Section 01 25 00 - Substitution Procedures: Substitutions made during procurement and/or construction phases.

B. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

C. Section 01 74 19 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting product selection, packaging and substitutions.

D. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment: Motors for plumbing equipment.

E. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Motors for HVAC equipment.

1.2 REFERENCE STANDARDS

A. NEMA MG 00001 - Motors and Generators; 2024.

1.3 SUBMITTALS

A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.1 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by Contract Documents.

B. Use of products having any of the following characteristics is not permitted:

C. Where other criteria are met, Contractor shall give preference to products that:

1. If used on interior, have lower emissions, as defined in Section 01 61 16.
2. If wet-applied, have lower VOC content, as defined in Section 01 61 16.

D. Motors: Refer to Section 22 05 13 - Common Motor Requirements for Plumbing Equipment, NEMA MG 00001 Type. Specific motor type is specified in individual specification sections.

E. Motors: Refer to Section 23 05 13 - Common Motor Requirements for HVAC Equipment, NEMA MG 00001 Type. Specific motor type is specified in individual specification sections.

2.2 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

PART 3 EXECUTION

3.1 SUBSTITUTION LIMITATIONS

A. See Section 01 25 00 - Substitution Procedures.

3.2 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport and handle products in accordance with manufacturer's instructions.

E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.3 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 01 74 19.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

G. Comply with manufacturer's warranty conditions, if any.

H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

I. Prevent contact with material that may cause corrosion, discoloration, or staining.

J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 01 60 00

SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

PART 2 PRODUCTS

2.1 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.4 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. Perform whatever cutting and patching is necessary to:

1. Complete the work.
2. Fit products together to integrate with other work.
3. Provide openings for penetration of mechanical, electrical, and other services.
4. Match work that has been cut to adjacent work.
5. Repair areas adjacent to cuts to required condition.
6. Repair new work damaged by subsequent work.
7. Remove samples of installed work for testing when requested.
8. Remove and replace defective and non-complying work.

C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

F. Restore work with new products in accordance with requirements of Contract Documents.

G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.

I. Patching:

1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
2. Match color, texture, and appearance.

3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.5 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.6 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.7 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.8 FINAL CLEANING

A. Use cleaning materials that are nonhazardous.

B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.

D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

E. Clean filters of operating equipment.

F. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, drainage systems, and _____.

G. Clean site; sweep paved areas, rake clean landscaped surfaces.

H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.9 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.

B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.

C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.

D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.

E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.

F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.

G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.

H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

~~MAINTENANCE~~

~~Provide service and maintenance of components indicated in specification sections.~~

~~Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.~~

~~Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.~~

~~Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.~~

~~Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.~~

END OF SECTION 01 70 00

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.1 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Contractor Reporting Responsibilities: Submit periodic Waste Disposal Reports; report landfill disposal, incineration, recycling, salvage, and reuse regardless of to whom the cost or savings accrues; use the same units of measure on required reports.

E. Methods of trash/waste disposal that are not acceptable are:

1. Burning on the project site.
2. Burying on the project site.
3. Dumping or burying on other property, public or private.
4. Other illegal dumping or burying.

F. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.2 RELATED REQUIREMENTS

A. Section 01 30 00 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. Section 01 50 00 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.

C. Section 01 60 00 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

D. Section 01 70 00 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

1.3 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.

1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
2. Submit Report on a form acceptable to Owner.
3. Landfill Disposal: Include the following information:

a. Identification of material.

b. Amount, in tons or cubic yards (cubic meters), of trash/waste material from the project disposed of in landfills.

c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.

d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.

4. Incinerator Disposal: Include the following information:

a. Identification of material.

b. Amount, in tons or cubic yards (cubic meters), of trash/waste material from the project delivered to incinerators.

c. State the identity of incinerators, total amount of fees paid to incinerator, and total disposal cost.

d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.

5. Recycled and Salvaged Materials: Include the following information for each:

a. Identification of material, including those retrieved by installer for use on other projects.

b. Amount, in tons or cubic yards (cubic meters), date removed from the project site, and receiving party.

c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.

d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.

e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.

6. Material Reused on Project: Include the following information for each:

a. Identification of material and how it was used in the project.

b. Amount, in tons or cubic yards (cubic meters).

c. Include weight tickets as evidence of quantity.

7. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 3 EXECUTION

2.1 WASTE MANAGEMENT PROCEDURES

A. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. See Section 01 50 00 for additional requirements related to trash/waste collection and removal facilities and services.

C. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.

D. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

2.2 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.

1. Prebid meeting.
2. Preconstruction meeting.
3. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.

1. Provide containers as required.
2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION 01 74 19

SECTION 01 78 00 - CLOSEOUT SUBMITTALS

END OF SECTION 01 78 00

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.1 SUMMARY

1.2 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures; except:

1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Provider.
2. Submit one copy to the Commissioning Provider, not to be returned.
3. Make commissioning submittals on time schedule specified by Commissioning Provider.
4. Submittals indicated as "Draft" are intended for the use of the Commissioning Provider in preparation of overall Training Plan; submit in editable .rtf or .docx electronic format unless otherwise approved.

1.3 QUALITY ASSURANCE

A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.

1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

END OF SECTION 01 79 00

SECTION 02 41 00 - DEMOLITION

PART 3 EXECUTION

1.1 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.

1. Obtain required permits.
2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
3. Provide, erect, and maintain temporary barriers and security devices.
4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
5. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
6. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Protect existing structures and other elements to remain in place and not removed.

1. Provide bracing and shoring.
2. Prevent movement or settlement of adjacent structures.
3. Stop work immediately if adjacent structures appear to be in danger.

1.2 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 02 41 00

SECTION 03 05 16 - UNDERSLAB VAPOR BARRIER

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sheet vapor barrier under concrete slabs on grade.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Preparation of subgrade, granular fill, placement of concrete.

1.3 REFERENCE STANDARDS

A. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2024.

B. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products.

C. Test Data: Submit report of tests showing compliance with specified requirements.

D. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction.

PART 2 PRODUCTS

2.1 MATERIALS

A. Underslab Vapor Barrier:

1. Water Vapor Permeance: ASTM E-96, Not more than 0.010 perms (0.6 ng/(s m2 Pa)), maximum.
2. Tensile Strenght: ASTM E-154 or D638, Class A - Over 45lbf/in.
3. Puncutre Resistance: ASTM E-154, Class B - Over 1700 grams.
4. Water Vapor Barrier: Meets or exceeds~~Complying with~~ ASTM E1745 Class ~~A~~B.
5. Thickness: 15 mils (0.4 mm).
6. Product:

    a. Stego Industries LLC; Stego Wrap Vapor Barrier (15-mil): www.stegoindustries.com/#sle.

B. Accessory Products: Vapor barrier manufacturer's recommended tape, adhesive, mastic, etc., for sealing seams and penetrations in vapor barrier.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surface over which vapor barrier is to be installed is complete and ready before proceeding with installation of vapor barrier.

3.2 INSTALLATION

A. Install vapor barrier in accordance with manufacturer's instructions and ASTM E1643.

B. Install vapor barrier under interior slabs on grade; lap sheet over footings and seal to foundation walls.

C. Lap joints minimum 6 inches (150 mm).

D. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.

E. No penetration of vapor barrier is allowed except for reinforcing steel and permanent utilities.

F. Repair damaged vapor retarder before covering with other materials.

END OF SECTION 03 05 16

SECTION 03 10 00 - CONCRETE FORMING AND 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.

B. General Notes, Plans, Sections, Typical Details and other notes indicated on the structural drawings. In cases of conflict, information indicated on the structural drawings shall govern.

C. All Specifications and Drawings shall be examined for requirements affecting the work of this trade. Coordinate work with that of other trades.

1.2 SUMMARY

A. Section Includes: Furnish all labor, equipment and services (including the design and detailing) required for “Forms” for all cast-in-place concrete indicated on the Contract Drawings and subsequent removal of all such “Forms” described in this Section.

B. Related Sections:

1. Section 032000 – Concrete Reinforcement
2. Section 033000 – Cast-In-Place Concrete

1.3 DEFINITIONS

A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 REFERENCE CODES AND STANDARDS

A. Codes and Standards: Work on this project shall conform to all requirements of the current version of the specifications or guides listed below except as modified by these contract documents.

1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
2. ACI 301 – Specifications for Structural Concrete for Buildings
3. ACI 347 – Guide to Formwork for Concrete

1.5 DESIGN REQUIREMENTS

A. All formwork, including reshoring, shall be designed by the formwork Contractor who shall be solely responsible for this work.

1.6 SUBMITTALS

A. Product Information: For each of the following:

1. Form ties.
2. Form-release agent.

1.7 QUALITY ASSURANCE

A. Qualifications of workmen: Provide at least one experienced person who shall be present at all times during execution of this portion of the “Work” and who shall be thoroughly familiar with the type of materials being installed, the referenced standards, and the requirements of this “Work”, and who shall direct all work performed under this Section.

PART 2 PRODUCTS

2.1 FORM MATERIAL AND ACCESSORIES

A. Form Lumber:

1. All form facing material in contact with exposed concrete shall be new or of sufficient quality to insure an unblemished texture.
2. All form facing material for all concrete, unless otherwise indicated, shall be one of the following or a combination thereof.

a. APA Structural 1 Plyform, B-B or better; mill-oiled and edge sealed. Minimum thickness: ¾”.

b. APA High Density Overlaid Plyform. Minimum thickness: ¾”.

B. Form Ties:

1. Factory fabricated, adjustable length, snap-off metal form ties, designed to prevent form deflection and to prevent spalling of concrete upon removal. Form ties shall be capable of providing a clean ¼” minimum break-back from wall surface and will leave no corrodible metal closer than 1” to the exposed surface face.

C. Form Release Agent:

1. A non-staining, colorless, barrier type which will not cause moisture absorption, softening or impede curing.
2. VOC Content: In compliance with applicable local, State, and federal regulations.
3. Standards:

a. Magic Kote – Dayton Superior

b. Formshield WB – The Euclid Chemical Company

c. FormKote OTC - Kaufman Products Inc

D. Falsework:

1. The contractor is responsible for the design, safety, and serviceability of falsework.

2.2 RELATED MATERIALS

A. Chamfer Strips: Wood, metal, PVC, or rubber strips, ¾” by ¾”, minimum.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection:

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is completed to the point where this installation may properly commence.
2. Verify that forms are constructed in accordance with all pertinent codes and regulations, the referenced standards, and the original design.

B. Discrepancies:

1. In the event of discrepancy, immediately notify the Architect/Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved and reviewed by the Architect/Engineer.

3.2 CONSTRUCTION OF FORMS

A. Construction of forms to be substantial, sufficiently tight to prevent leakage of concrete, and able to prevent excessive deflection when filled with wet concrete.

B. Layout:

1. Form all required cast-in-place concrete to the shapes, sizes, lines and dimensions indicated on the Drawings. Provide ¾" chamfers on all exposed corners of concrete except those abutting or aligning with masonry.
2. Exercise particular care in the layout of formwork to avoid necessity for cutting of concrete after it is in place.
3. Make proper provision for all openings, offsets, recesses, anchorage, blocking, and other features of the Work as shown or required.
4. Perform all forming required for Work of other trades and do all cutting and repairing of forms required to permit such installation.
5. Carefully examine the Drawings and Specifications and consult with other trades as required relative to provision for openings, reglets, chases and other items in the forms.

C. Bracing:

1. Properly brace and tie the formwork together to maintain position and shape and to ensure safety of workers.

D. Construct all formwork straight, true, plumb, level and square within a tolerance as specified in ACI 117. Use a reference point on the ground to check plumbness and elevations. Do not use a previous floor as the reference.

E. Keep formwork sufficiently wetted to prevent joints opening before concrete is placed.

F. Provide holes at bottom of formwork for cleaning and inspection. Close prior to placing concrete.

3.3 INSTALLATION OF 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.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Clean embedded items immediately prior to concrete placement.

3.4 FOOTING FORMS

A. Wood Forms:

1. Footing and pile cap formwork shall be formed with wood, unless it can be sufficiently demonstrated to the satisfaction of the independent geotechnical testing and inspection agency that the footing excavation is sufficiently stable to prevent detrimental sloughing of the sides of the excavation into the bottom of the excavation.

3.5 FORM REMOVAL

A. Remove formwork in an approved manner under competent supervision to avoid damage to the concrete. Care shall be taken to avoid spalling.

B. The Contractor shall bear full responsibility for form removal. Concrete damaged by too early removal of supports shall be repaired to the satisfaction of the Architect/Engineer or replaced.

C. Shores and other formwork shall not be removed until concrete has attained sufficient strength to support its self-weight without objectionable deflections including all anticipated construction loads.

1. For non-post-tensioned concrete, the concrete shall have attained, as indicated by the field-cured cylinders, at least 70 percent of its specified 28-day strength before falsework is removed.

3.6 MAINTENANCE

A. Formwork shall be cleaned and reconditioned before each use. Any damage to formwork during placing, removal, or storage shall be completely repaired. Formwork with repairs or patches which would result in adverse effects to the concrete finish shall not be used.

B. Storage of formwork and form materials shall be in a manner to prevent damage or distortion.

END OF SECTION 03 10 00

SECTION 03 20 00 - CONCRETE REINFORCING

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. General Notes, Plans, Sections, Typical Details and other notes indicated on the structural drawings. In cases of conflict, information indicated on the structural drawings shall govern.

C. All Specifications and Drawings shall be examined for requirements affecting the work of this trade. Coordinate work with that of other trades.

1.2 SUMMARY

A. Section Includes: Furnish all labor, equipment, materials and services required for the installation of all concrete reinforcement and associated items required and/or indicated on the Contract Drawings or specified herein.

B. Related Sections:

1. Section 031000 – Concrete Forming and Accessories
2. Section 033000 – Cast-In-Place Concrete

1.3 REFERENCE CODES AND STANDARDS

A. Codes and Standards: Work on this project shall conform to all requirements of the current version of the specifications or guides listed below except as modified by these contract documents.

1. ACI 315 – Manual of Standard Practice for Detailing Reinforced Concrete Structures.
2. ACI MNL-66 - ACI Detailing Manual
3. ACI 318 – Building Code Requirements for Reinforced Concrete.
4. CRSI (DA4) - Concrete Reinforcing Steel Institute - Manual of Standard Practice.
5. CRSI (P1) - Concrete Reinforcing Steel Institute - Placing Reinforcing Bars, 10th Edition.
~~AWSD 1.4 – Structural Welding Code – Reinforcing Steel.~~

1.4 SUBMITTALS

A. Submittal schedule, administrative and procedural requirements shall comply with Division 01, Submittal Procedures.

B. Shop Drawings: Prepared under the provisions of Division 01 and in accordance to ACI MNL-66 Detailing Manual:

1. Include all details, sections, and installation instructions indicated on the structural drawings that are required by the contractor to place the reinforcement without using the structural drawings.
2. Grades of reinforcement shall be shown as indicated.
3. Bar bending diagrams shall be provided for all bent bars.
4. Reinforcing lap splice table shall be shown for the concrete strengths indicated.

5. Reinforcing support bolsters and chairs shall be indicated as to size and spacing on the sections and the elevations.
6. Sections of walls, beams, joists and slabs shall be provided showing clearly bar positions and clearances to forms.
7. Beams, Walls and Columns: ¼ inch scale elevations shall be provided with all the reinforcing shown on the elevations, not scheduled. Provide a hook orientation diagram for the top of the concrete column.
8. Slabs and Mats: Reinforcing for all concrete slabs and mats shall be shown on a floor plan drawn exclusively for this use. Reinforcing shall not be scheduled. This plan shall include a support system where the maximum spacing of support bars or bolsters is 4'-0" and the maximum overhang beyond a support bar or bolster is 1'-0" typical, unless noted otherwise

1.5 QUALITY ASSURANCE

A. Qualifications of workmen: Provide at least one experienced person who shall be present at all times during execution of this portion of the "Work" and who shall be thoroughly familiar with the type of materials being installed, the referenced standards, and the requirements of this "Work", and who shall direct all work performed under this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protection:

1. Use all means necessary to protect concrete reinforcement before, during and after installation and to protect the installed work and materials of all other trades.
2. Store in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
3. Use all necessary precautions to maintain identification after the bundles are broken.

B. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect/Engineer and at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 CONCRETE REINFORCEMENT

A. All concrete reinforcement materials shall be new, free from rust, and complying with the following reference standards:

1. Steel Reinforcing Bars: ASTM A-615, Grade 60, deformed billet-steel bar
2. Stirrups and Column Tie-Bars: ASTM A-615, Grade 60, deformed billet-steel bar
3. Plain-Steel Welded-Wire Reinforcement: ASTM A1064

a. Flat sheets

b. WWR Style: As indicated on Drawings

2.2 REINFORCEMENT ACCESSORIES

A. Plain Smooth Joint Dowel Bars: ASTM A615 Grade 60.

B. Bar supports shall be stainless steel or protected with plastic in contact area. When underneath side of floor is to be exposed and painted, bar supports shall be stainless steel or cementitious material.

1. Bar supports for slab-on-ground shall be such that it will not puncture the specified underslab vapor barrier, if applicable.

C. Side form spacer to maintain clearances for vertical wall reinforcement.

1. Standard: PSW – Aztec Space Wheel by Dayton Superior Corporation.

D. Mechanical Splice Couplers:

1. Conforming to ACI 318 with material strengths equal to or greater than reinforcing bar being spliced.
2. Standards: Tension-Compression

a. Bar Lock Couplers System by Dayton Superior.

b. Taper-Lock Threaded System by Dayton Superior.

c. Shear Bolt Splicing System by nVent Lenton.

d. Taper-Threaded Splicing System by nVent Lenton

3. Standards: Compression-Only

a. D630 Compression Only Coupler by Dayton Superior.

b. Speed Sleeve Coupler by nVent Lenton.

E. Dowel Bar Replacement System:

1. Conforming to ACI 318 with material strengths equal to or greater than reinforcing bar being spliced.
2. Standards:

a. D50 DBR Coupler by Dayton Superior.

b. Taper-Lock form Saver by Dayton Superior.

c. Form Saver Coupler System by nVent Lenton.

F. Rebar Anchorage System:

1. Conforming to ACI 318 with material strengths equal to or greater than reinforcing bar being spliced.
2. Alternative to hooked rebar anchorage.
3. Standards:

a. Taper-Lock End Anchor by Dayton Superior.

b. Terminator by nVent Lenton.

PART 3 EXECUTION

3.1 FABRICATION

A. Fabrication, including bar bending shall comply with the requirements of ACI 318, ACI 315 and CRSI "Manual of Standard Practice."

3.2 PREPARATION

A. Inspection:

1. Prior to installation of the work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that concrete reinforcement shall be installed in strict accordance with all pertinent codes and regulations, the approved Shop Drawings, and the original design.

B. Discrepancies:

1. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved and reviewed by the Architect/Engineer.

3.3 INSTALLATION OF STEEL REINFORCEMENT

A. Installation shall be completed in accordance with approved shop drawings. An approved set of shop drawings shall be used during the installation.

B. All reinforcement shall be held securely in design position by wiring to supports in accordance with CRSI standards and, in addition, any other supports needed to secure every bar against displacement shall be provided. Overhanging tails shall be supported positively. Walking on top slab bars shall be avoided. All bars bent and/or displaced during concrete placement shall be straightened and repositioned before they are encased in concrete.

C. Tolerances on reinforcing placement must comply with ACI 117 – “Specifications for Tolerances for Concrete Construction and Materials.”

D. Concrete protection shall comply with the requirements of ACI 318 except as modified on the Structural Drawings.

E. Mechanical splicing of main reinforcement will not be permitted unless set out on the Structural Drawings or approved by the Architect/Engineer. Mechanical Splice Couplers to be installed in accordance with manufacturer's instructions.

F. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on the Structural Drawings.

G. Obstructions:

1. In the event conduits, piping, inserts, sleeves or any other items interfere with placing reinforcement as indicated on the Drawings or as otherwise required, immediately consult the Architect/Engineer and obtain approval of new procedure before placing concrete.

H. Install welded-wire reinforcement in longest practicable lengths and supported in accordance with CRSI "Manual of Standard Practice."

1. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire.
2. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
3. Lace overlaps with wire.

3.4 FIELD QUALITY CONTROL

A. Contractor shall notify the Architect/Engineer and the Owner's Testing Agency, if applicable, when reinforcement for a pour is nearing completion so that reinforcing steel in place may be reviewed.

1. For all floor pours, roof pours, and mats; the installation of all reinforcement shall be completed by noon of the day prior to casting the concrete.
2. Allow sufficient time for setters to make adjustments or corrections so that reinforcing steel correct in size, shape and position will be in place when concreting is started.

B. The Owner’s Testing Agency shall inspect all in-place reinforcing steel for compliance with the contract documents and approved shop drawings. This inspection shall include, but not necessarily be limited to, bar size, concrete cover, lap lengths mechanical splice couplers and bar supports. Daily inspection reports shall address all areas which have been inspected, and any deficiencies.

END OF SECTION 03 20 00

SECTION 03 30 00 - 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.

B. General Notes, Plans, Sections, Typical Details and other notes indicated on the structural drawings. In cases of conflict, the strictest interpretations shall govern between the specifications and structural drawings.

C. All Specifications and Drawings shall be examined for requirements affecting the work of this trade. Coordinate work with that of other trades.

1.2 SUMMARY

A. Section Includes:

1. Materials, equipment, services, hardware and labor required for placing, finishing and curing all cast-in-place concrete.
2. Installation of all specified items to be embedded in cast-in-place concrete.
3. Mud slabs and flowable fill (if contract documents require its use).

B. Related Sections:

1. Section 031000 – Concrete Forming and Accessories
2. Section 032000 – Concrete Reinforcing
3. Division 07 - Thermal and Moisture Protection

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 REFERENCE CODES AND STANDARDS

A. Codes and Standards: Work on this project shall conform to all requirements of the current version of the specifications or guides listed below except as modified by these contract documents.

1. ACI 117 – Specification of Tolerances for Concrete Construction and Materials
2. ACI 211.1 - Selecting Proportions for Normal-Density and High-Density Concrete
3. ACI 301 – Specifications for Structural Concrete
4. ACI 302.1R – Guide to Concrete Floor and Slab Construction
5. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete
6. ACI 305.1 – Guide to Hot Weather Concreting
7. ACI 306.1 – Guide to Cold Weather Concreting
8. ACI 308 - Guide to External Curing of Concrete
9. ACI 309R – Guide for Consolidation of Concrete

10. ACI 318 – Building Code Requirements for Reinforced Concrete
11. ACI 544.3R – Guide for Specifying, Proportioning and Production of Fiber Reinforced Concrete
12. ASTM A820 – Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
13. ASTM C33 – Standard Specification for Concrete Aggregates
14. ASTM C94 – Standard Specification for Ready-Mixed Concrete
15. ASTM C143 - Standard Test Method for Slump of Concrete
16. ASTM C150 – Standard Specification for Portland Cement
17. ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete
18. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
19. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
20. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
21. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete
22. ASTM C618 – Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolans for Use in Concrete
23. ASTM C989 – Standard Specification for Slag Cement for use in Concrete and Mortars
24. ATSM C1116 - Standard Specification for Fiber-Reinforced Concrete
25. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

1.5 SUBMITTALS

A. Submittal schedule, administrative and procedural requirements shall comply with Division 01, Submittal Procedures.

B. Concrete Mix Designs:

1. Submit a mix design for each class of concrete required for the project under the provisions of Division 1 and including:

a. Standard deviation analysis, required average strength and documentation of average strength verifying compliance with ACI 318.

b. Mix proportions by weight, water-cement ratio, slump and air content.

c. Sieve analyses of fine and coarse aggregates.

d. Cement manufacturer’s letter of certification and chemical content test results stating that the “Portland Cement” is compliant with ASTM specifications.

e. Complete list of concrete materials specified in Section 2.1 with product information demonstrating compliance with all specified requirements

2. Submit with enough time allowed for review before concrete is required for the project.

~~Shop Drawings:~~

~~Submit complete shop drawings under the provisions of Division 01 and indicating:~~

~~Sizes and locations of sleeves. Provide a single set of coordination drawings that consolidate sleeve requirements for all disciplines.~~

~~Coordinated steel embed placement drawings. Show embedment details and locations for all embeds to be cast in concrete for all trades including structural steel, curtain wall, handrail, and stairs. Consolidate into a single set of drawings to be used solely for this purpose. Reproductions of structural drawings shall not be used.~~

C. Product Information:

1. Submit product information for related materials specified in PART 2 - PRODUCTS under the provisions of Division 1 and demonstrating compliance with specified requirements.

D. Field Quality Control Test Reports: Submit to the Architect/Engineer under the provisions of Division 1 and within 3 days after completion of the 7-day and 28-day tests.

E. Slab finish tolerance compliance test reports as specified in Section 3.4.

F. Concrete Placement Records: Turn over to the Architect/Engineer after completion of the project.

1.6 QUALITY ASSURANCE

A. Contractor shall be responsible for all quality assurance, including both the workmanship and the material provided by his subcontractors and/or furnished by the material suppliers.

B. Perform work in accordance with the following standards:

1. ACI 301 – Specifications for Structural Concrete.
2. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
3. ACI 318 – Building Code Requirements for Reinforced Concrete.

C. Conduct field sampling and concrete testing:

1. All concrete testing shall be provided by an independent testing agency retained by the owner approved by the Architect/Engineer and qualified according to ASTM C1077 “Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation”, ASTM E329 “Specification for Agencies Engaged in Construction Inspection, Testing or Special Inspection” and perform required testing in accordance with the ASTM E548 “Standard Guide for General Criteria Used for Evaluating Laboratory Competence.”
2. Any independent testing agency retained by the contractor or subcontractor shall meet the same qualifications and requirements as stated in paragraph 1 above.
3. Personnel conducting field tests shall hold current certificates issued by the Concrete Technician Certification Committee of ACI.

D. Each type or class of cementitious material shall be of the same brand and from the same manufacturer's plant, each aggregate type shall be from one source, and each individual admixture from the same manufacturer.

E. All concrete shall be provided and delivered to the job site by a firm with a minimum of 5 years of experience in manufacturing ready-mixed concrete complying with the requirements of ASTM C94 “Standard Specification for Ready-Mixed Concrete”. The firm must also hold a National Ready Mixed Concrete Association’s Certification of Ready Mixed Concrete Production Facility.

F. All interior slabs-on-grade shall be placed, finished and cured under the direct supervision of a “Certified ACI Concrete Flatwork Technician” and shall also have a minimum of 5 years of experience in concrete flatwork installations.

G. During the installation of all concrete work, the Contractor shall employ a competent foreman with a minimum of 5 years of experience and thoroughly conversant with all practical working details of reinforced concrete construction. This foreman shall supervise all concrete operations including but not limited to form placement, reinforcing steel placement, concreting and curing operations to the exclusion of other duties.

H. If applicable, the Contractor shall attend a preconstruction meeting to discuss submittals, concrete placement, finishing, curing and concrete testing. A responsible representative of the concrete placing/finishing contractor, the concrete supplier and the independent testing agency shall be present.

I. In the event of a conflict between the contract documents and the specifications a “Request for Information” (RFI) shall be submitted to the Architect/Engineer for clarification.

J. Materials and/or installed work may require testing as directed by the Architect/Engineer or the Code Officials at any time during the construction process.

1. The Contractor shall provide the testing agency with the construction and operations schedule a minimum of 48 hours prior to execution of the task. Failure to provide such schedule within the stated time frame may result in additional cost to the Contractor.
2. The Contractor shall fully cooperate with the testing agency and provide enough access to the testing location including any off-site location where materials are fabricated, batched or stored. The Contractor shall also provide any incidental equipment and labor required to facilitate the required testing and inspection operations.
3. Testing and/or inspections by an independent agency does not relieve the Contractor of his responsibility to perform all work in accordance with the Contract Documents.
4. Additional tests required as a result of rejected installed work or material or as requested by the Contractor shall be at the Contractor’s expense.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver concrete in accordance with "ASTM C94 - Standard Specification for Ready-Mixed Concrete". Do not use non-agitating transporting equipment.

B. Deliver materials and equipment in undamaged condition.

C. Store materials and equipment in designated areas and in accordance with manufacturer's instructions.

D. Store materials and equipment off the ground, totally protected from ground splash, mud, weather separation, intrusion of foreign materials, and other damage.

1.8 FIELD CONDITIONS

A. Inclement Weather: Do not place concrete during rain, sleet or snow unless adequate protection is provided.

B. Hot and Cold Weather: Perform work under the provisions of Part 3 – Execution.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS AND ADMIXTURES

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150, Type I/II, unless otherwise noted, from an approved domestic manufacturer.
2. Fly Ash: ASTM C618, Class C or F.
    a. Maximum loss on ignition: 3.0 percent.
    b. Maximum amount retained when wet-sieved on No. 325 sieve: 30 percent.
3. Ground Granulated Blast Furnace Slag: ASTM C989, Grade 120.

C. Coarse Aggregate: ASTM C33.

1. All concrete: ¾" maximum aggregate size. Crushed stone or gravel of clean, sound, tough, durable particles.
    a. Air-entrained concrete mixes: ASTM C33, Class 4S.
    b. Non-air-entrained concrete mixes: ASTM C33, Class 2S.
    c. Sieve analysis to conform to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
1"	100
3/4"	90 - 100
1/2"	---------
3/8"	20 - 55
No. 4	0 - 10
No. 8	0 - 5

D. Fine Aggregate: ASTM C33

1. Natural sand of clean, hard, durable particles.
2. Sieve analysis to conform to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
3/8"	100
No. 4	90 - 100
No. 6	---------
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	10 - 30
No. 80	----------
No. 100	2 - 10

E. Water: Clean and free from injurious amounts of oil, acids, alkalis, salts, organic materials and other deleterious substances.

F. Air-Entraining Admixture: ASTM C260.

1. Standards:

a. Sika AEA-14 by Sika Corporation.

b. MasterAir AE 90 by Master Builders Solutions.

c. Darex AEA by GCP Applied Technologies.

d. Eucon AEA-92” by The Euclid Chemical Company.

G. Water-Reducing Admixture: ASTM C494, Type A.

1. Standards:

a. Plastocrete-161 by Sika Corporation.

b. MasterEase 5000 by Master Builders Solution

c. WRDA 60 by GCP Applied Technologies.

d. Eucon A+ by The Euclid Chemical Company.

H. Mid-Range Water Reducing Admixture: ASTM C494, Type A.

1. Standards:

a. SikaPlast-200 by Sika Corporation.

b. MIRA 85 by GCP Applied Technologies.

c. MasterPolyheed 1025 by Master Builders Solutions.

d. Eucon MR by The Euclid Chemical Company.

I. High Range Water-Reducing Admixture: ASTM C494, Type F.

1. Standards:

a. ViscoCrete-2100 by Sika Corporation.

b. MasterRheobuild 1000 by Master Builders Solution.

c. Adva 140M by GCP Applied Technologies.

d. Eucon SP by The Euclid Chemical Company.

2. High range water reducing admixture shall be added to the concrete at the batch plant. Field added HRWR can correct slump non-compliance per Part 3, Field Quality Control.

J. Accelerating Admixture: ASTM C494, Type C.

1. Standards:

a. SikaSet NC by Sika Corporation.

b. Master Set AC 534 by Master Builders Solution.

c. Polarset by GCP Applied Technologies.

d. Accelguard 90 by The Euclid Chemical Company.

2. The accelerator shall be non-chloride, non-corrosive. Calcium chloride, or admixtures containing more than 0.05% chloride ions are not permitted.
3. Thiocyanate-based accelerators, when used at the given dosage rate, shall contribute thiocyanate ions less than 0.30 percent by weight of cement. This shall be certified by the manufacturer. Thiocyanate based accelerators are not allowed in post-tensioned concrete.

K. Water-Reducing & Retarding Admixture: ASTM C494, Type D.

1. Standards:

a. Sika Retarder-22 by Sika Corporation.

b. Masterset R 300 by Master Builders Solutions.

c. Daratard-17 by GCP Applied Technologies.

d. Eucon Retarder 100 by The Euclid Chemical Company.

2.2 FIBER REINFORCEMENT

~~Carbon-Steel-Wire Fiber: ASTM A820, Type 1.~~

~~2" minimum length (unless specified otherwise).~~
~~Minimum dosage rate of 25 lbs/cubic yard. Use in strict accordance with manufacturer's instructions.~~
~~Fibers shall be introduced into the concrete at the batch plant, and it shall be noted on all delivery tickets.~~

~~Standards:~~

~~Novocon HE-4550 by Sika Corporation.~~

~~MasterFiber 515 by Master Builders Solutions~~

~~PSI Steel Fiber C6560 by Euclid Chemical Company.~~

A. Synthetic Macro-Fiber: ASTM C1116.

1. Virgin (non-recycled), nylon or polypropylene fibers.
2. 1 1/2" minimum length (unless specified otherwise).
3. Minimum dosage rate of 3 lbs/cubic yard. Use in strict accordance with manufacturer's instructions.
4. Fibers shall be introduced into the concrete at the batch plant, and it shall be noted on all delivery tickets.
5. Standards:

   a. Sika Fibermesh-650 by Sika Corporation.

   b. MasterFiber MAC 100 by Master Builders Solutions.

   c. Tuf-Stand SF by Euclid Chemical Company.

   d. Strux 90/40 by GCP Applied Technologies

2.3 RELATED MATERIALS

A. Curing and Sealing Compounds:

1. Curing Compound (exterior slabs, stoops, and stairs): ASTM C309.

   a. Clear curing, non-staining, non-coloring under ultra-violet light and be able to withstand early construction traffic without damage. Sodium silicate products are not permitted.

   b. Curing compound shall be applied at the coverage rate complying with ASTM C 309 specifications.

~~Curing and Sealing Compound (interior concrete slabs without floor finishes for high wear resistance i.e. industrial floors): ASTM C309.~~

~~Clear styrene acrylate type – 30% solids content minimum.~~

~~Compound shall have test data from an independent testing agency indicating a maximum moisture loss of 0.030 grams per sq. cm. when applied at a coverage rate of 300 sq. ft. per gallon.~~

~~Sodium silicate compounds are not permitted.~~

~~Standards:~~

~~Cure & Seal WB 30 by SpecChem~~

~~Super Rex Seal by The Euclid Chemical Company.~~

~~Sikagard-300 KNS by Sika Corporation~~

2. Curing and Sealing Compound (interior concrete slabs subject to “water-based flooring adhesives” for carpeting and resilient floor finishes): ASTM C1315.

    a. Clear curing, non-staining, non-coloring under ultra-violet light and be able to withstand early construction traffic without damage. Sodium silicate products are not permitted.

    b. Ensure compatibility with the floor adhesive.

    c. Standards:

        1) Cure & Seal 25 by SpecChem

        2) Diamond Clear by The Euclid Chemical Company

        3) Sikagard-1315 KNS by Sika Corporation

B. Moisture Retention Cover: ASTM C171.

1. Waterproof paper or polyethylene film.
2. Standards:

    a. UltraCure NCF by Sika Corporation

    b. Armorlon Transguard 4000 by Reef Industries

    c. Hydracure S16 by PNA Construction Technologies

C. Evaporation Retardant:

1. Apply in accordance with manufacturer's installation instructions.
2. Standards:

    a. MasterKure ER 50 by Master Builders Solutions

    b. Eucobar by the Euclid Chemical Company

    c. SikaFilm by Sika Corporation

D. Epoxy Bonding Adhesive: ASTM C881.

1. Used to bond fresh, plastic concrete or patching mortar to hardened concrete.
2. Two-part structural epoxy adhesive.
3. Standards:

    a. Sikadur-32 Hi-Mod by Sika Corporation

    b. Euco #452 by The Euclid Chemical Company

E. Doweling Adhesive Anchor System for Reinforcing Steel: ASTM C881.

1. Use to anchor reinforcing steel into hardened concrete.
2. Moisture insensitive epoxy.
3. Standards:

a. HIT-HY 200-A/R V3 by Hilti, Inc

b. ET-3G by Simpson Strong-Tie Company, Inc.

c. Sika AnchorFix-3001 by Sika Corporation

d. Approved equal: Submit literature including depth of embedment to develop reinforcing bars/anchor rod and spacing requirements.

4. Drilled hole size and installation procedure shall conform to manufacturer's instructions.
5. Use carbide bit drill to prevent damage to reinforcement.

F. Epoxy Crack-Injection Adhesive: ASTM C881.

1. 100 percent solids, high modulus, low viscosity, moisture tolerant, epoxy polymer, for gravity feed or pressure injection of concrete cracks.
2. Tensile Strength: Not less than 7000 psi (48.3 MPa), when tested in accordance with ASTM D638.
3. Concrete Bond Strength: Not less than 3600 psi (24.8 MPa) after 14 days, when tested in accordance with ASTM C882.
4. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.

G. Patching Material (Repair Mortar):

1. Use to repair honeycombed and other defective concrete.
2. Standards:

a. SikaTop 122 Plus (horizontal surfaces) by the Sika Corporation.

b. SikaTop 123 Plus (overhead and vertical surfaces) by the Sika Corporation.

c. EucoPatch (vertical and overhead surfaces) by Euclid Chemical Company

H. Waterstops:

1. PVC flat ribbed or dumbbell type:

a. Provide waterstops with center bulb at all expansion joints and as detailed.

b. Split-fin type waterstop is acceptable at construction joints and expansion joints.

c. Provide all corner joints and tee joints in prefabricated assemblies. Field splices shall be used for butt joints only, using controlled indirect heating element per manufacturer's requirements.

d. Standards:

1) Greenstreak PVC Waterstop by Sika Corportation

2) Durajoint PVC by DCA Construction Products

3) Approved equal: Submit literature

2. Hydophilic (Swelling) type:

a. Use for non-expanding concrete joint.

b. Keep dry at all times.

c. Standards:

1) Waterstop-RX by Cetco

2) Swellstop by Sika Corporation

3) Expand-Tite by DCA Construction Products

4) Approved equal: Submit literature

I. Isolation Joint Filler: ASTM D1751.

1. Isolation joint filler shall be flexible, lightweight, non-straining, polyethylene, and closed cell. It shall be a chemical-resistant, ultraviolet stable, non-absorbent, low density, compressible foam
2. The joint filler shall have a pre-scored “removable strip” to provide a uniform sealing reservoir in the joint. This reservoir shall be used to provide a sealed joint with a flexible sealant in accordance with the Construction Documents.
3. Use at isolation joints at columns and adjacent to walls.
4. Standards:

a. X-Foam Expansion Joint Filler by W.R. Meadows

b. Foamtech by NMW, Inc.

J. Floor Control/Construction Joint Filler:

1. Flexible multi-part urethane sealant.
2. Non-sag or self-leveling.
3. Use to fill control joints and construction joints in slabs-on-grade.
4. Standards:

a. Sikaflex NP 2 by Sika Corporation.

b. Eucolastic 1NS by The Euclid Chemical Company.

c. Dymonic 100 by Tremco Inc.

2.4 PROPORTIONING CONCRETE MIXES

A. Establish concrete proportions to produce homogeneous, durable mixes with the required average strength based on the appropriate amount of overdesign as required by Section 5.3 of ACI 318.

B. Proportion concrete mixes to provide workability and consistency to permit concrete to be worked readily into the corners and angles of the forms and around reinforcement by the methods of placement and consolidation to be employed, without segregation or excessive bleeding.

C. Include a water-reducing admixture, a mid-range water-reducing admixture or high-range water-reducing admixture, used in strict accordance with manufacturer's instructions, in all

mix designs. Specified minimum cement contents are based on the use of such admixtures.

D. Include an air-entraining admixture in mix designs for all concrete exposed to freezing and thawing during service.

E. Base mix design on saturated surface dry aggregates. Adjust the amount of mixing water added at the batch plant for the moisture condition of the aggregates.

1. The water-cementitious ratio given for each class of concrete shall be calculated using the amount of Portland Cement plus flyash plus Slag Cement. For “Class C” flyash, use 100 percent of flyash; for “Class F” flyash, use 80 percent of flyash; for Slag Cement, use 100 percent of the Slag Cement.

F. Flyash may be used as a cement substitute with a maximum 20 percent substitution rate on a pound for pound basis for “Class C” flyash and a maximum 15 percent substitution rate using 1.25 pounds of flyash for 1.00 pound of cement for “Class F” flyash.

G. Slag Cement may be used as a substitute for Portland Cement on a pound for pound basis. The maximum substitution rate shall be 50%, except for “Class 4E and 4ESOG (exterior concrete)” and for “Class 4LW (structural lightweight concrete)”. For these classes of concrete, the max substitution shall be 30%.

H. When Slag Cement and flyash are used in the same concrete mix, the maximum substitution rates for Slag Cement and flyash shall comply with the following:

1. Portland Cement/Slag Cement/Flyash Ratio:

a. Exterior Concrete (Class 4ESOG): 70% / 20% / 10%

b. All other concrete: 50% / 30% / 20%

I. For concrete to be cast during cold-weather (refer to specification section “Cold-Weather Concreting”, the maximum substitution rate for Slag Cement shall be 30%. If slag Cement and flyash are used in the same concrete mix, the maximum substitution rates shall comply with a ratio of Portland Cement/Slag Cement/Flyash of 70% / 20% / 10%.

J. Water Soluble Chloride Ion Content:

1. Maximum percent in concrete by weight of cement:

a. Reinforced concrete for water retention structures: 0.10

b. Reinforced concrete exposed to earth or weather: 0.15

c. Other reinforced concrete construction: 0.30

2. For each pound of chloride ion in excess of the amount allowed, the mix shall contain a corrosion inhibitor additive at a rate of one gallon for each pound of chloride ion in excess of the amount allowed. A maximum of 1.5 pounds of chloride ion may be compensated in this matter. The minimum dosage shall be one half gallon per cubic yard.

K. Concrete Slump:

1. Mixes containing water-reducing admixture: 5 inches maximum, u.n.o.
2. Mixes containing mid-range water-reducing admixture: 5 to 6 ½ inches, u.n.o.
3. Mixes containing high range water-reducing admixture: 5 to 8 inches, u.n.o.

L. Adjustments to the approved mix designs may be requested by the Contractor when job conditions, weather, test results, or other circumstances warrant. These revised concrete mix designs shall be submitted to the Architect/Engineer for approval prior to their use.

2.5 CONCRETE MIXTURES

A. Class 3: Isolated column footings and continuous wall footings:

1. Compressive strength at 28 days: 3,000 psi.
2. Minimum cement content: 423 lb/cu yd.
3. Maximum water-cementitious ratio: 0.58.
4. Air content: 6± 1 percent.
5. Water-reducing admixture required.

B. Class 4: Concrete foundation walls and piers~~, grade beams, pile caps~~:

1. Compressive strength at 28 days: 4,000 psi.
2. Minimum cement content: 517 lb/cu yd.
3. Maximum water-cementitious ratio: 0.48.
4. Air content: 6± 1 percent.
5. Mid-range water-reducing admixture required.

C. Class 4I: Interior slab-on-grade~~, slab-on-composite metal deck, interior concrete-filled metal pan stairs~~:

1. Compressive strength at 28 days: 4,000 psi.
2. Minimum cement content: 517 lb/cu yd.
3. Maximum water-cementitious ratio: 0.48.
4. Air content: 0 to 3 percent.
5. High-range water-reducing admixture required.
6. Fiber reinforcement, if specified, incorporated in mix at batch plant

D. Class 45E: Exterior slabs-on-grade, walls and piers exposed to freezing-and-thawing and in continuous contact with moisture and exposed to deicing chemicals (i.e. exterior loading dock, exterior frost-protected entrances, exterior concrete stairs, exterior equipment pads):

1. Compressive strength at 28 days: 4,500 psi.
2. Minimum cement content: 564 lb/cu yd.
3. Maximum water-cementitious ratio: 0.45.
4. Coarse aggregate: Crushed stone.
5. Air content: 6± 1 percent.
6. High-range water-reducing admixture required.

2.6 BATCHING AND MIXING

A. Final proportions shall be in accordance with approved mix designs. Adjustments to approved proportions, for whatever reason, shall be approved by the Architect/Engineer.

B. Batch and mix concrete in accordance with ASTM C94.

C. Batch and transit equipment shall be adequate for the work and operated as necessary to provide concrete complying with specified requirements.

D. Add fibrous concrete reinforcing to all concrete where it has been specified. The amount of fiber reinforcement shall be in accordance with the manufacturer's recommendations and approved submittals. Add the fibrous reinforcement at the time the concrete is batched; mix in strict accordance with the manufacturer's instructions and recommendations for a uniform and complete distribution.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Install items to be embedded in concrete. Set steel frames, angles, trench drains, bolts, inserts, and other such items required to be anchored in the concrete before the concrete is placed. Position accurately and secure against displacement:

1. Anchor rods shall be installed in accordance with the tolerances indicated in the AISC-303 Code of Standard Practice for Steel Buildings and Bridges, Section 7.5.
2. Do not embed aluminum items in concrete.

B. Remove wood scraps, ice, snow, frost, standing water and debris from areas in which concrete will be placed.

C. Before fresh concrete is placed against hardened concrete, retighten forms and suitably clean and moisten the surface of the hardened concrete for bond to the fresh concrete.

D. Thoroughly moisten subgrade on which concrete is to be placed. Do not place concrete on frozen subgrade.

E. Thoroughly clean conveying and handling equipment.

F. Installation of vapor retarder/barrier beneath slab on grade shall be in accordance with ASTM E1643.

1. Follow manufacturer’s instructions for placement (including laps, sealing around penetrations and foundation walls), protection and repair.
2. Place vapor retarder/barrier sheeting with the longest dimension parallel to the direction of the concrete pour.
3. Do not use reinforcing supports that will puncture the vapor barrier.
4. Repair all damaged areas.

3.3 SURFACE CONDITIONS

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.

B. Verify that concrete can be placed to the required lines and elevations with required cover for reinforcement.

C. Prevent groupings of conduits, pipes and sleeves in concrete that would significantly impair the strength of the concrete.

D. Notify the Architect/Engineer when concrete placement is planned. Allow sufficient time for review of formwork, reinforcement and embedded items, and for any required corrective work.

3.4 CONCRETE PLACEMENT

A. Addition of water to the concrete during transport or at the site is strictly prohibited. Slump may be adjusted at the site by the addition of high-range water reducer, if necessary.

B. Convey concrete by methods and equipment capable of supplying concrete from mixer to place of final deposit without segregation and such that detectable setting of concrete does not occur before adjacent concrete is placed.

C. Use pumping equipment with sufficient design and pumping capacity to ensure a practically continuous flow of concrete at the point of discharge without segregation.

1. Do not add water or alter the mix design in any way to facilitate pumping.
2. Pumping concrete through aluminum pipe is prohibited.

D. Concrete may be placed in columns and walls by “free fall” providing a tremie is used to control concrete to fall without hitting the formwork, reinforcing, or any embedded items.

E. Do not bear concrete conveying equipment on fresh concrete or reinforcement.

F. After concrete placing has started, provide continuous operation until placement of the section is complete. Do not place a greater section at one time than can be properly finished.

G. Deposit concrete as nearly as practicable to its final position to avoid segregation due to re-handling or flowing.

H. Place concrete at a rate such that the concrete is always plastic and flows readily between reinforcement and into corners of forms without segregation.

I. Place concrete in all slabs, mats, and beams for the full depth of the member at one time in such a way as to prevent a horizontal cold joint from occurring.

J. All concrete shall be discharged into the structure within 90 minutes after batching.

K. Do not place concrete that has partially hardened, been re-tempered or contaminated by foreign materials.

3.5 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes: ACI 301

1. Surface Finish SF-1.0: Formed concrete surfaces not exposed to public view. As-cast concrete texture imparted by form-facing material.

a. Patch voids larger than 1-1/2 inches wide or 1/2 inches deep in accordance with Section 3.6.

b. Remove fins and projections larger than 1 inch.

c. Tie holes do not require patching.

d. Surface Tolerance: Class D as specified in ACI 117.

e. Mockup not required.

B. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.6 REPAIR OF DEFECTIVE AREAS

A. Remove honeycombed and other defective concrete, exposing sound concrete. Cut and chip edges straight and perpendicular to the surface or slightly undercut to a depth of ½". Featheredges are not permitted.

B. Dampen areas to be patched and surrounding areas. Patch with patching material according to manufacturer's recommendations. Submit data on patching material to Architect/Engineer for review prior to starting repair.

C. After surface water has evaporated from the area to be patched, apply patching material to the surface.

D. Apply curing to the repaired surface as soon as possible and maintain for a minimum of 3 days.

3.7 FINISHING FLOORS AND SLABS

A. Tolerances: ACI 117

1. Finish level slabs to conform to the following minimum F-numbers.

a. Slabs-on-grade:

1) SOFF (specified overall flatness) = 25

2) MLFF (minimum local flatness) = 17

3) SOFL (specified overall levelness) = 20

4) MLFL (minimum local levelness) = 14

~~Unshored elevated slabs on wood forms, steel forms or metal deck:~~

~~SOFF (specified overall flatness) = 25~~

~~MLFF (minimum local flatness) = 17~~

~~Maintain the required minimum slab thickness at all locations, increasing the thickness as required to compensate for deflections and camber. The top surface of slabs poured on structural steel framing shall not deviate from the specified elevation by more than plus or minus ¾" at any location. Measurements should be made in the absence of any live loads on the slab.~~

2. Compliance tests shall be in accordance with the "Field Quality Control" section of the specifications.
3. The maximum area to be considered for minimum local FF and FL numbers shall be 400 square feet.
4. Remedial work in areas of non-compliance may be required at the Owner's request. This work shall be accomplished by grinding and/or using a self-leveling underlayment concrete or by using a self-leveling, polymer modified industrial topping.

B. Screeding:

1. Immediately after placing, strike off excess concrete with a straightedge to bring the top surface to proper grade, aligning it to the contours of screeds.
2. Screed off edge forms, intermediate screed strips or pipe set accurately and firmly to the required elevations and contours for the finished surface.
3. Move straightedge across the concrete surface with a sawing motion, advancing forward a short distance with each movement. There should be a surplus of concrete against the front face of the straightedge to fill in low areas as the straightedge passes over the surface.
4. Complete screeding before any excess moisture or bleeding water is present on the surface.

C. Bull Floating or Leveling:

1. Immediately after screeding, bull float the concrete surface, eliminating high and low spots, smoothing the surface and embedding the coarse aggregate.
2. Avoid overworking the concrete. Do not close up or seal the surface of the concrete.
3. Complete bull floating before any excess moisture or bleeding water is present on the surface.

D. Floating:

1. Begin floating operations when bleeding water has disappeared or been removed from the surface and when the surface has stiffened sufficiently to support the operation.

    a. Do not use dry cement and sand to take up bleeding water.

2. Hand or power float the concrete surface, removing slight imperfections and producing a relatively even and true surface with a uniform, sandy texture prepared for final finishing.
3. Avoid overworking the concrete. Do not close-up or seal the surface of the concrete.

E. Final Finishing:

1. Hard Trowel Finish: All slabs unless otherwise specified.

a. Immediately after floating, use power trowel for first troweling to produce a smooth surface relatively free of defects.

b. For first troweling, use hand troweling in areas inaccessible to power troweling.

c. Use hand trowel and heavy pressure for final troweling after concrete has become hard enough to produce a ringing sound as the trowel is moved over the surface. Produce a smooth, hard, dense surface, uniform in texture and appearance and free of defects.

2. Broom Finish: Slip-resistant surfaces.

a. Immediately after floating, draw a broom across the concrete surface transversely to the main direction of traffic, producing a coarse, scored, slip-resistant texture.

3.8 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and maintain concrete in a moist condition for at least 5 days at temperatures above 70□F and at least 7 days at temperatures between 40□F and 70□F.

B. Hot Weather Concreting: Comply with ACI 301 and ACI 305.1.

1. Follow the provisions of this Section and ACI 305.1 when the rate of evaporation of surface moisture from the concrete exceeds 0.18 lb/sq ft/hr.
2. Control concrete setting time with the use of water-reducing & retarding admixtures as required to facilitate placing and finishing operations.
3. Before placing concrete, spray the subgrade, forms and reinforcement with water to keep them cool and to prevent absorption of water from the freshly placed concrete.
4. Transport, place and finish concrete as quickly as practicable. Plan concrete delivery, placing techniques and consolidation methods to avoid cold joints.
5. Maximum temperature of concrete during placing: 90□F. (85 degrees for polished concrete).
6. Apply evaporation retardant to the surface of the fresh concrete after screeding and as needed during finishing.
7. Take additional precautions as necessary to prevent plastic shrinkage cracking.
8. Start curing the concrete immediately after finishing operations have been completed.

C. Cold Weather Concreting: Comply with ACI 301 and ACI 306.1.

1. Follow the provisions of this Section and ACI 306.1 when the average daily temperature (average of the highest and lowest temperature during the period from midnight to midnight) is less than 40□F.
2. Control concrete setting time with the use of accelerating admixtures and water-reducing accelerating admixtures as required to facilitate placing and finishing operations.

    a. Do not use calcium chloride as an accelerating admixture. Only the specified accelerators in Section 2.0 of the specifications shall be used.

3. Temperature of concrete during placing: 55□F to 75□F.
4. Maintain the temperature at the concrete surface between 55□F and 75□F until the concrete reaches 70 percent of its specified compressive strength by providing heated enclosures and insulated blankets.

    a. Construct weathertight enclosures, allowing the heated air to circulate around the outer edges of the concrete.

    b. Provide enough heaters to assure an even temperature within the enclosure.

        1) Use indirect-fired heaters vented to the exterior where heat is supplied to the top of fresh concrete to prevent dusting due to carbonation.

    c. Add moisture to the heated air as required to maintain a minimum relative humidity of 40 percent within the enclosure. Do not allow any concrete surface to become dry during the protection period.

    d. Maintain enclosures for 24 hours after heating has been discontinued to allow the concrete to cool gradually.

    e. Lap insulating materials and cover the edges and corners of the concrete to provide complete and adequate protection.

    f. Wrap columns and walls with insulated blankets.

    g. Monitor the temperature of the concrete surface regularly with suitable thermometers throughout the protection period.

5. Provide insulation or temporary backfill to protect all earth supported concrete from damage due to frost heaving.

D. Curing Slabs: Curing compounds or moisture retention covers. Comply with ACI 308.1.

1. Apply curing compounds to the concrete surface, immediately after final finishing of the concrete, in accordance with manufacturer's instructions and complying with ASTM C309 and ASTM C1315.

    a. If it is determined that the curing compound is not compatible with the floor finish after the curing compound has been applied, then the curing compound must be removed by mechanical abrasion.

2. Place moisture retention covers on the concrete surface immediately after final finishing of the concrete. Lap edges 6 inches and seal, creating a moisture barrier that must remain intact for the duration of the curing period.

E. Curing Formed Surfaces: Comply with ACI 308.1.

1. Formed surfaces may be cured by leaving forms in place. During hot, dry weather, keep forms moist by sprinkling.
2. When forms are removed before the end of the curing period, apply curing compound to walls and columns.

3.9 JOINTS

A. Construction Joints:

1. Locate construction joints so as not to impair the strength of the structure.
2. Except for slabs-on-grade, continue reinforcement across construction joints.
3. Thoroughly clean the concrete surface at construction joints and remove laitance before placing adjoining concrete.
4. Beams, girders or slabs supported by columns or walls shall not be cast until the concrete in vertical support members is no longer plastic.
5. In slabs-on-grade with control joints, locate construction joints at control joint locations.

B. Slabs-on-Grade Control Joints:

1. Sawcut Control Joints:

a. Conventional: Sawcut joints as soon as the blade does not dislodge aggregate and when the edges of the cut do not ravel. For slabs to remain exposed, use a blade that has a triangular arbor configuration to reduce edge reveling or dislodging aggregates. Complete saw-cutting before shrinkage stresses become sufficient to produce cracking. Sawcut joints in straight lines to avoid unsightly joints.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified testing and inspecting agency for Special Inspection Services as dictated in the Contract Documents. The Agency shall perform field tests and inspections and prepare testing and inspection reports to be submitted to Architect/Engineer.

1. Testing agency shall immediately report to Architect/Engineer, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
2. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect/Engineer, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

a. Field Quality Control Test reports shall include reporting requirements of ASTM C31, ASTM C39, and ACI 301, including the following as applicable to each test and inspection:

1) Name of Testing Agency
2) Project identification and portion of structure represented.
3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
4) Name of concrete manufacturer, truck, and batch ticket numbers.
5) Concrete mix class and specified compressive strength requirements.
6) Date and time of inspection, sampling, and field testing.
7) Date and time of concrete placement, weather conditions and air temperature.
8) Concrete temperature, slump and air content test results.
9) Concrete Strength test results indicating type of fracture and compressive break strengths at 7 and 28 days.
10) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.

B. Rejection of Concrete:

1. Any concrete that is not discharged into the forms within 90 minutes after batching shall be rejected in accordance with ASTM C94.
2. Any concrete that does not meet the specified field-testing requirements for slump, air-entrainment or concrete temperature shall not be placed until corrective measures have been taken, and the concrete has been re-tested to indicate compliance.
3. The Owner or Owner’s Construction Manager shall authorize one party to be responsible for rejection of concrete.

C. Concrete Strength Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C172 shall be performed in accordance with the following requirements:

1. Make and cure a minimum of five (5) cylinders in accordance with ASTM C31 for each of the following:
   a. Each 50 cubic yards of concrete.
   b. Each 3000 square feet of surface area for slabs and walls.
   c. Each class of concrete placed in a day's work
2. Test each group of four (5) cylinders in accordance with ASTM C39 as follows:
   a. Two (2) field-cured cylinders to be tested at 7 days or just before anticipated time of form removal. For post-tensioned concrete, test cylinders prior to stressing of tendons.
   b. Two (2) laboratory-cured cylinders to be tested at 28 days.

c. One (1) laboratory-cured cylinders to be tested at 56 days if 28 day breaks do not meet specified compressive strength.

3. 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. The strength level of an individual class of concrete will be considered satisfactory if each strength test equals or exceeds the specified compressive strength.
4. If the strength level of an individual class of concrete is found to be unsatisfactory, conduct core testing in accordance with ASTM C42 or nondestructive testing such as Impact hammer, sonoscope, or other nondestructive device as permitted by the Architect/Engineer. If such testing does not produce acceptable results, corrective measures will be required to ensure structural adequacy.

D. Slump Test: ASTM C143:

1. One slump test at point of placement for each group of five (5) cylinders, but not less than one test for each day's pour of each concrete mixture.
2. When concrete is pumped, make the slump test at the point of discharge.
3. Keep a slump cone available at the site for additional testing as required when concrete consistency appears to change.

E. Air Content Tests: ASTM C231 or ASTM C173

1. One air content test for each group of five (5) cylinders for air-entrained concrete mixes at point of discharge, but not less than one test for each day's pour of each concrete mixture.

a. Use the pressure method, ASTM C231, for normal-weight concrete mix.

b. Use the volumetric method, ASTM C173, for light-weight concrete mix.

F. Concrete Temperature Test: ASTM C1064:

1. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

G. Compliance Tests for floor flatness and levelness tolerances: ASTM E1155.

1. Slab measurements and computation of F-numbers shall conform to ASTM E 1155.
2. Compliance tests shall be performed by an independent testing laboratory.
3. Compliance tests shall be completed within 24 or 72 hours after the final finishing is complete and prior to the removal of any forms and shoring.
4. If cold weather protection prevents testing, then compliance tests shall be performed immediately after the removal of the protection and prior to the removal of any forms and shoring.

3.11 PROTECTION

A. Protect finished concrete surfaces from damage from construction equipment, material storage and staging, petroleum and acidic detergents, rain or running water.

B. Protect liquid floor treatment from damage and wear during the remainder of construction period by using protective methods recommended by the liquid floor treatment installer.

C. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

D. Do not load any concrete member in such a way as to overstress the concrete.

END OF SECTION 03 30 00

SECTION 05 12 00 - 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.

B. General Notes, Plans, Sections, Typical Details and other notes indicated on the structural drawings. In cases of conflict, information indicated on the structural drawings shall govern.

C. All Specifications and Drawings shall be examined for requirements affecting the work of this trade. Coordinate work with that of other trades.

1.2 SUMMARY

A. Section includes: The work under this Section consists of providing all labor, materials and equipment necessary or required for the complete fabrication and erection of all structural steel as detailed on the Contract Drawings and as specified herein. The work includes furnishing and installing all steel accessories and the non-shrink grout beneath the structural steel.

1. Structural steel.
2. Bolts, washers and other steel accessories.
3. Shear stud connectors.
4. Non-shrink grout.
5. Anchor rods, embed plates, and other embed connection components in concrete. To be furnished but not installed.

B. Related Sections:

~~Section 052100 – Steel Joist Framing.~~
~~Section 053113 – Steel Floor Decking.~~

1. Section 053123 – Steel Roof Decking.
2. Section 055000 – Metal Fabrications.
3. Division 09 – Paintings and Coatings.

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/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 QUALITY ASSURANCE

A. The latest editions of the following standard specifications and guides shall govern the fabrication and erection of the structural steel, except as modified by the design drawings or this specification:

1. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.
2. AISC 360 - Specifications for Structural Steel Buildings.
3. AISC 341 - Seismic Provisions for Structural Steel Buildings.
4. RCSC - Specification for Structural Joints Using High Strength Bolts.
5. AWS D1.1 - Structural Welding Code for Steel.
6. AWS D1.3 - Structural Welding Code for Sheet Steel.
7. AWS B2.1 - Specification for Welding Procedure and Performance Qualification.
8. SSPC - Steel Structures Painting Council Specifications.

B. All welders in both shop and field shall be certified under AWS "Standard Qualification Procedure" for the type or types of welding being performed and shall have been continuously engaged in such welding.

C. Fabricator and Erector shall have continuous business operation for at least 5 years. Furthermore, by evidence of a minimum of 5 projects similar in complexity to this project, indicate capability of conducting work of a similar nature; have sufficient well maintained equipment to perform the work; maintain an adequate stockpile of materials; and have qualified labor to fabricate or erect without delaying the project.

1. Fabricator to have participated in the AISC Quality Certification Program and is designated as an “AISC-Certified Building Fabricator, Category BU”.
2. Erector to have participated in the AISC Quality Certification Program and is designated as an “AISC-Certified Steel Erector, Category CSE”.

D. Shop-Painting Applicators shall be qualified per AISC Sophisticated Paint Endorsement P1 (enclosed), P2 (covered), and P3 (outside).

1.6 SUBMITTALS

A. Submittal schedule, administrative and procedural requirements shall comply with Division 01, Submittal Procedures.

B. Shop Drawings: Shall be submitted to the Architect/Engineer and will be checked by the Architect/Engineer for correct interpretation and conformance of the Contract Documents. However, this check shall not relieve the General Contractor from ensuring that the shop drawings conform to the Contract Documents.

1. Resubmitted shop drawings:

a. All information which is correct on the original submittal will not be changed in any way on the resubmitted shop drawings.

b. Shop drawings that have been re-submitted will not be reviewed unless all revisions are “clouded”. Only “clouded” items will be reviewed.

2. Shop drawings shall be prepared under the provisions of Division 01 and in accordance with the following:

    a. Shop Drawings shall include erection plans, framing elevations, all shop and erection details including cambers, copes, cuts, holes, connections, threaded fasteners, and welds.

    b. Provide setting drawings, templates and directions for installation of anchor rods and other devices.

    c. Erection plans shall clearly denote locations of all connections which require field welds, slip critical bolts, and any bolts other than ¾" diameter A325, if specified.

    d. Shop drawings shall include the grade of steel, connection bolt and anchor rod material types, and the type of welding rods.

    e. Submit a dimensioned layout of shear connectors for each composite steel beam.

    f. Identify surface preparation and finishes.

3. Delegated-Design Connection Submittal:

    a. The Steel Fabricator via the General Contractor is responsible for the design of all connections not specifically designed and detailed on the Contract Documents or covered by AISC design tables. Specifically, these include:

        ~~Truss panel connections.~~

        ~~Truss end connections.~~

        ~~Truss splices.~~

        ~~Column splices.~~

        1) Moment-resisting connections.

        2) Lateral Bracing connections.

        3) Skewed shear connections.

    b. Connection design shall utilize "Load and Resistance Factor Design" Specifications.

    c. All connection designs and details are subject to acceptance by the Structural Engineer of Record (SER).

    d. Calculations shall be prepared under the supervision of a Licensed Professional Engineer fully experienced in steel connection design. Connection calculations are to be signed and sealed by a Licensed Professional Engineer registered in the State where the project is located.

    e. Signed and sealed connection designs shall be submitted with the structural steel shop drawing submittal. Structural steel submittals will be returned without review if provided without supporting connection design calculations.

f. Calculations and details shall be clearly keyed to the appropriate members on the construction documents.

g. Simple shear “beam-to-column” and “beam-to-beam” connections shall be designed as follows:

~~Composite beams: Beam end connections shall be designed for the vertical reaction indicated on the structural framing plans. Where no beam end reaction is indicated, connection is to be designed for a minimum of 12 kips. The reactions shown on the plans are based on LRFD Ultimate Loads and are shown as factored.~~

1) Non-composite beams (beams without shear studs): Beam end connections shall be designed for the vertical reaction indicated on the structural framing plans. Where no beam end reaction is indicated, connection is to be designed for a minimum of 12 kips. The reactions shown on the plans are based on LRFD Ultimate Loadsand are shown as factored.

2) All bolted connections shall have a minimum of two (2) bolts.

3) Beam end connections will require to be checked/designed for any “axial load” indicated on the floor plans.

h. Design of bracing connections shall utilize the “Uniform Force Method” as defined in the AISC “Steel Construction Manual,” with a connection geometry that does not induce moment on the connected beam or column. Lateral brace “axial forces” are indicated on the contract documents.

~~Unless noted otherwise on the framing plans, moment-resisting connections shall be designed for the full moment capacity of the beam or per the requirements of AISC 341 “Seismic Provisions for Steel Buildings”, if applicable. Bolted moment-resisting connections shall not reduce the flange area of the beam by more than 15 percent.~~

i. Steel Fabricator via General Contractor is responsible for ensuring all connections meet the requirements of AISC standards. All components necessary to construct complete connections, including shop and field welding, bolting, connection plates and angles shall be included.

1.7 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. Keep material protected from dirt, grease, or other foreign matter.

1. Do not store materials in a manner that might cause distortion, damage, or overload to members or supporting structures. Any materials exhibiting damage shall be repaired or replaced as directed by the Architect/Engineer and at no additional cost to the Owner.

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 re-lubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

C. Requirements for storage and handling of electrodes shall be per AWS D1.1.

1.8 COORDINATION

A. Coordinate delivery of anchor bolts and anchorage devices to be embedded into concrete prior to start of concrete construction to avoid disruption to schedule.

B. As-built field surveys and verifications shall be completed by the Contractor as required to document existing conditions from completed concrete construction or existing buildings prior to the development of shop drawings.

C. Coordinate selection of shop primers with topcoats to be applied over them, where specified. Comply with paint and coating manufacturer’s recommendations to ensure that shop primers and topcoats are compatible.

PART 2 PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992, Grade 50 (Fy = 50 ksi).

B. Column Base Plates: ASTM A36 (Fy = 36 ksi), unless noted otherwise.

C. Angles, Channels, Plates and Bars: ASTM A36 (Fy = 36 ksi).

D. Plate and Bar: ASTM A36 (Fy = 36 ksi).

E. Rectangular and Square HSS: ASTM A500, Grade C (Fy = 50 ksi).

~~Round HSS members: ASTM A500, Grade C (Fy=46 ksi).~~

2.2 BOLTS AND CONNECTORS

A. Heavy-hex steel structural bolts:

1. ASTM A325 Bolt, Type 1: Minimum tensile strength 120 ksi.

a. Heavy-hex nuts: ASTM A563, Grade C.

b. Hardened washers: ASTM F436, Type 1.

c. Direct Tension Indicator: ASTM F959, Type 325.

d. Galvanizing, if specified: Hot-dipped (ASTM A153, Class C) or mechanically deposited (ASTM B695, Class 50) zinc coating.

2. ASTM A490 Bolt, Type 1: Minimum tensile strength 150 ksi.

a. Heavy-hex nuts: ASTM A563, Grade DH.

b. Hardened washers: ASTM F436, Type 1.

c. Direct Tension Indicator: ASTM F959, Type 490.

d. Galvanizing, if specified: Hot-dipped (ASTM A153, Class C) or mechanically deposited (ASTM B695, Class 50) zinc coating.

3. Tension Control, High-Strength Bolt-Nut-Washer Assembly.

a. A325 type (minimum tensile strength 120 ksi): ASTM F3125

b. A490 type (minimum tensile strength 150 ksi): ASTM F3125

B. Unheaded Anchor Rods: ASTM F1554, Grades 36, 55 or 105 as indicated.

1. Configuration: Straight (hooked anchor rods are not permitted, u.n.o.)
2. Heavy-hex nuts: ASTM A563, Grade C.
3. Hardened washers: ASTM F436, Type 1.
4. Plate washers: ASTM A36 carbon steel.
5. Galvanizing, if specified: Hot-dipped (ASTM A153, Class C) or mechanically deposited (ASTM B695, Class 50) zinc coating.

C. Headed Anchor Rods: ASTM F1554, Grades 36, 55 or 105 as indicated.

1. Heavy-hex nuts: ASTM A563, Grade C.
2. Hardened washers: ASTM F436, Type 1.
3. Plate washers: ASTM A36 carbon steel.
4. Galvanizing, if specified: Hot-dipped (ASTM A153, Class C) or mechanically deposited (ASTM B695, Class 50) zinc coating.

~~Shear Connectors (steel headed stud anchors): AWS D1.1, Type B made from ASTM A108, Grade 1015 material (Fu = 65 ksi).~~

~~Standards: Acceptable products include, but are not limited to the following:~~

~~Nelson Weld Studs by Stanley Engineering Fastening.~~

~~Tru-Weld Steel Headed Stud Anchors by Tru-Weld Stud Welding~~

~~Shear connectors shall have an ES Report adhering to the International Code Council (ICC).~~
~~The use of manually welded anchors, rods, bars, straps, or reinforcing bars is not acceptable as a substitute for headed studs anchors.~~

~~Deformed bar anchors: AWS D1.1 and ASTM A496.~~

~~Standards: Acceptable products include, but are not limited to the following:~~

~~"Nelson D2L Deformed Bar Anchor Studs" by Nelson Stud Welding, Inc.~~

~~"Deformed Bar Anchors" by Tru-Weld Division, TFP Corp.~~

~~Deformed bar anchors shall have an ES Report adhering to the International Code Council (ICC).~~

~~The use of manually welded anchors, rods, bars, straps, or reinforcing bars is not acceptable as a substitute for deformed bar anchors.~~

D. Post-Installed Wedge Anchors:

1. Expansion anchor appropriate for attachment to solid masonry or concrete (cracked or un-cracked), with diameter, embedment and finish as indicated on the contract documents. Acceptable products include, but are not limited to the following:

   a. “Kwik Bolt-TZ2” Wedge Anchor by Hilti, Inc.

   b. “Power-Stud+SD2” Wedge Anchor by Dewalt Anchors and Fasteners.

   c. “Strong-Bolt 2” Wedge Anchor by Simpson Strong-Tie Company, Inc.

2. Expansion anchor shall have an ES Report demonstrating the anchor has met the requirements of AC 193 for mechanical anchors as specified by the International Code Council (ICC).

E. Post-Installed Screw Anchors:

1. Screw anchor appropriate for attachment to solid masonry or concrete (cracked or un-cracked), with diameter, embedment and finish as indicated on the contract documents. Acceptable products include, but are not limited to the following:

   a. “KH-EZ” Screw Anchor by Hilti, Inc.

   b. “Screw-Bolt+” Screw Anchor by Dewalt Anchors and Fasteners.

   c. “Titen HD” Screw Anchor by Simpson Strong-Tie Company, Inc.

2. Screw anchor shall have an ES Report demonstrating the anchor has met the requirements of AC 193 for mechanical anchors as specified by the International Code Council (ICC).

F. Post-Installed Anchoring Adhesive System:

1. Anchoring adhesive plus threaded rod appropriate for attachment to solid masonry or concrete (cracked or un-cracked), with diameter, embedment and finish as indicated on the contract documents. Acceptable products include, but are not limited to the following:

   a. “HIT-HY 200 A/R V3 Anchoring Adhesive by Hilti, Inc.

   b. “AC200+” Anchoring Adhesive by Dewalt Anchor and Fasteners.

   c. “ET-3G” Anchoring Adhesive by Simpson Strong-Tie Company, Inc.

2. Adhesive anchoring system shall have an ES Report demonstrating the anchor has met the requirements of AC 308 for adhesive anchors as specified by the International Code Council (ICC).

2.3 WELDING MATERIALS

A. Filler metal requirements shall conform to AWS D1.1 and AISC “Specification for Structural Steel Buildings”, minimum tensile strength of 70 ksi (E70).

B. Filler metal “Charpy V-Notch (CVN)” requirements:

1. 20 ft-lb at 0 degrees Fahrenheit unless noted otherwise.
2. 20 ft-lb at 70 degrees Fahrenheit for all complete penetration (CJP) groove welds.

C. Welding Rods:

1. AWS E70XX for A36 steel.
2. AWS E70XX low hydrogen for Grade 50 steel.

2.4 NON-SHRINK GROUT

A. Standards: Acceptable products include, but are not limited to the following:

1. “Five Star Grout” by Five Star Products, Inc.
2. “SikaGrout 212” by Sika Corporation.
3. “NS Grout” by The Euclid Chemical Company.

B. Shrinkage-resistant Grout shall be non-metallic, non-staining, non-corrosive, factory-packaged requiring only the addition of potable water.

C. Grout shall attain compressive strengths per ASTM C1107 and be capable of maintaining a flowable consistency for a minimum of 45 minutes at 70 Deg F.

D. Grout shall meet the dimensional stability requirements of ASTM C1107, Grade C, when prepared according to the manufacturer's instructions and tested at 40 Deg F and 90 Deg F.

2.5 SHOP PRIMER

A. Comply with Division 9 Section “Paintings and Coatings”

B. Primer shall be compatible with finish paints, intumescent paint and spray-on fireproofing specified elsewhere.

C. Primer paint shall be lead-free, chromate-free, non-asphaltic, rust-inhibiting and comply with all applicable SSPC requirements.

D. Galvanizing Repair Paint to comply with ASTM A780.

PART 3 FABRICATION

3.1 SHOP FABRICATION

A. Fabricate structural steel in accordance with AISC 303 "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360 “Specifications for Structural Steel Buildings”. Assemble structural steel members and parts in the shop to its greatest extent possible.

1. Camber structural-steel members where indicated. Camber indicated is the required camber at time of erection. Fabricate beams with rolling camber up.

2. Identify high-strength structural steel according to ASTM A6 and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly. Members shall be fabricated for delivery in a sequence that will expedite erection and minimize field handling of structural steel.
4. Hollow members exposed to weather shall be sealed with continuous welds or provided with weep holes to eliminate accumulation of water.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting:

1. Perform thermal cutting by machine to greatest extent possible.
2. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Cleaning:

1. Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP2, “Hand Tool Cleaning”.

D. Headed Shear Studs:

1. Prepare steel surfaces as recommended by the manufacturer of headed shear studs. Use automatic end welding of headed shear studs according to AWS D1.1 and manufacturer’s written instructions.

E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

1. Use standard holes unless otherwise indicated on the Contract Documents. Holes shall be drilled or punched perpendicular to the surface of the metal. Making or enlarging holes by burning is not allowed.
2. Flame cut holes for fasteners are not acceptable.
3. Holes in column baseplates shall be drilled (not punched) and shall not be larger than 1/2-inch greater than the nominal bolt size specified.

F. Openings: Provide openings in structural members as required for securing other work to structural steel and for other work to pass through steel framing members, as shown on final shop drawings.

1. Provide holes, slots, and rectangular/square penetrations, along with specified reinforcing, as indicated on the Contract Documents. Openings shall only be located where shown on the drawings. If the opening location is to be changed, revised location needs approval by the Structural Engineer of Record (SER) prior to fabrication.
2. Openings shall only be completed in the fabrication shop and shall be coordinated by the Contractor prior to fabrication. Openings will not be allowed in the field unless specifically approved by the Structural Engineer of Record (SER).
3. Holes shall be drilled or punched perpendicular to the surface of the metal. Creating or enlarging holes by burning is not allowed.

G. Finishing:

1. Accurately finish ends of columns and other members transmitting bearing loads.

H. Fabricator, Erector, and General Contractor shall coordinate safety requirements for the project, in accordance with OSHA Part 1926. Provide all necessary pieces and fabrications as required to safely erect and access the structure for the duration of the project construction.

3.2 SHOP CONNECTIONS

A. General:

1. Provide high strength threaded fasteners for all bolted connection, except where an alternative is specified in the Contract Documents.
2. Bolts shall be of adequate length to ensure the bolt is at least flush with the surface of the connecting nut and not extending greater than the nut height.
3. Bolts shall be installed with threads excluded from the shear plane, unless indicated otherwise in the contract documents.
4. Washers shall be used for all bolted connections. Use beveled washers where bolts bear on sloping surfaces.

B. Bolted Connections:

1. Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
2. Unless otherwise indicated, all bolted connections shall be tightened to snug-tight condition as specified by AISC.

C. Welded Connections:

1. Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
2. Weld sizes where shown shall be assumed to be “effective weld” sizes.
3. Where structural steel members are to remain exposed in the finished work, welds exposed to view shall be uniformly made and ground smooth, unless noted otherwise in the Contract Documents. Refer to AESS Specifications if applicable.
4. Do not weld at the flange to web intersection of structural steel members denoted by AISC as the “k” and “k1” distances unless specifically noted otherwise.

3.3 SHOP PRIMING

A. Shop prime structural steel surfaces except the following.

1. Contact surfaces of high-strength bolted, slip-critical connections.
2. Surfaces to be field welded.
3. Structural steel that will receive sprayed-on fireproofing.
4. Steel encased in concrete.
5. Embedded steel items (surfaces in contact with concrete).
6. Top surface of the top flange for all composite beams.
7. Crane rails.
8. Galvanized surfaces.

B. Surface Preparation:

1. Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces as follows, unless noted otherwise in contract documents:

    a. SSPC – SP3 “Power Tool Cleaning” for structural steel not exposed to weather.

    b. SSPC – SP6 “Commercial Blast Cleaning” for structural steel exposed to weather.

C. Application of Primer:

1. Immediately after surface preparation, structural steel shall receive shop primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 2 mils for interior primer and 3 mils for exterior primer.
2. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

D. Field Repairs/Touch-Up:

1. Field repair damaged surfaces or locations not coated in the shop, including but not limited to field welded steel, construction damage, and damage caused by shipping and erection.

3.4 SHOP GALVANIZING

A. Hot-Dip Galvanized Finish:

1. Apply zinc coating by the hot-dip process to structural steel according to ASTM A123 and to bolts, nuts, and washers according to ASTM A153.
2. All steel exposed to the weather in the final structure shall be hot-dipped galvanized, unless noted otherwise in contract documents. The following structural steel items will also require galvanizing:

    a. Any steel indicated as “galvanized” on the contract drawings as well as all fasteners connecting the galvanized components.

    b. Steel lintels and shelf angles within the exterior wall assembly.

3. 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.
4. Provide drain holes in closed tubular members to be galvanized. Holes shall not be located to impact the strength of the member. Holes shall be shown on the shop drawings for review by the Engineer.
5. Surface Preparation: SSPC – SP6 “Commercial Blast Cleaning.”

3.5 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections as defined by AWS, AISC, and this specification.

1. Provide testing agency with access to places where structural steel work is being fabricated or produced to perform tests and inspections.
2. Owner may waive shop inspections upon receipt of required fabricator certification.

3. Testing agency shall summarize their findings in inspection and testing reports. Reports shall identify any deficiencies not in compliance with project requirements.

B. Contractor shall ensure all discrepancies noted in testing agency reports are corrected and re-inspected to confirm acceptable repair. Any costs associated with re-inspection of non-conforming work shall be at the Contractor's expense.

C. Bolted Connections: Test and Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

D. Welded Connections:

1. Testing agency shall visually inspect all shop welding of structural steel in accordance with the governing building code and AWS D1.1.

a. Multi-pass welds shall be continuously inspected.

2. In addition to visual inspection, shop-welded connections shall be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option.

a. Ultrasonic Inspection: ASTM E164.

b. Radiographic Inspection: ASTM E94.

E. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1 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 on additional shear connectors if weld fracture occurs on shear connectors already tested.

PART 4 EXECUTION

4.1 EXAMINATION

A. Prior to the erection of any steel, the Contractor, with the steel erector present, shall verify the location, elevation and plumbness of all anchor rods, bearing plates, embedments and concrete surfaces. The Contractor shall report immediately to the Architect/Engineer in writing any condition which he finds unacceptable or that would prevent erection of the structural steel within AISC tolerance for plumbness and elevation. The Contractor shall be responsible for all corrections, and all corrections shall be made in a manner acceptable to the Architect/Engineer.

B. The erector shall acquaint himself with all conditions at the site, which can affect his methods and sequence of operations. Abide by Owner's regulations concerning traffic, parking and construction material delivery.

C. Contractor to furnish all anchor rods for anchorage of structural steel at an advance date for incorporation into the concrete foundation by others. Provide heavy hex nuts and washers for each bolt. Anchor rods shall not be installed until shop drawings have been reviewed.

4.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports as required to maintain stability and alignment during erection against temporary construction loads and loads equal in intensity to design loads.

B. Remove temporary supports only when the entire structural steel system is erected, permanently connected, braced and set. This includes the composite floor slab system, if applicable, where it must attain concrete design compressive strength prior to removal.

C. Contractor is solely responsible for the inclusion and maintenance of all temporary support systems. Retain the services of a Specialty Structural Engineer (not the Engineer of Record) to design specialty shoring and bracing.

4.3 ERECTION

A. Erect Steel in accordance with AISC 303 “Code of Standard Practice for Steel Buildings and Bridges” and AISC 360 “Specifications for Structural Steel Buildings.”

B. Set all structural steel accurately to lines and grades. Connect temporarily with sufficient high strength bolts to ensure complete safety of the structural until permanent connections are made. Ensure plumbness after erection of each level.

C. Erection tolerances shall be in accordance with the AISC 303 “Code of Standard Practice for Steel Buildings and Bridges.”

D. Erection tolerances shall be in accordance with the AISC 303 “Code of Standard Practice for Steel Buildings and Bridges.

E. Baseplates and Bearing Plates:

1. Concrete surfaces and plates shall be clean and free from rust, grease, oil and other debris. Roughen surfaces prior to setting plates.
2. Set plates for structural members on wedges, shims, or setting nuts as required. Leveling plates under column base plates will not be permitted unless noted otherwise in the contract documents.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims. Welding of anchor rods for corrective measures is not acceptable unless specifically approved by the Structural Engineer of Record (SER).
4. Baseplate grouting:

    a. Place a watertight form around the area to be grouted. Formwork should be designed to ensure free flow of the grout under the baseplate and preventing the creation of air pockets. The height of the formwork should be sufficient to allow for complete gravity fill under the plate.

    b. Saturate the area to be grouted with water until uniformly damp. Remove excess water just before placing the grout.

c. To avoid air pockets and ensure complete filling of the cavity between the baseplate and concrete, the grout shall be placed from one side only. Placement shall be completed without interruption.

d. Dry-packing or damp packing is not allowed

e. See manufacturer's printed instructions for additional information regarding preparation, mixing, placement and curing of the grout.

F. All misfits shall be reported to the Architect/Engineer for resolution. Burning of new or unfair holes or cutting with a torch will not be permitted without the approval of the Structural Engineer of Record (SER). Reamers, twist drills and saws shall be employed where burning is prohibited.

G. Any member that has assumed a bend or buckle in its final position due to forced fit shall have one or both ends and any intermediate connections unbolted and re-drilled or reamed to relieve such bowing to the satisfaction of the Structural Engineer of Record (SER).

H. No piece that has been bent, broken, twisted or otherwise damaged shall be incorporated into the work. Such pieces shall be repaired or corrected on the ground to the satisfaction of the Engineer or replaced with a new piece. Failure to observe this will be cause for rejection of the piece in place.

~~Splice members only where indicated on the Contract Drawings.~~

I. Remove Primer or any coating from the area to be welded prior to field welding.

4.4 FIELD CONNECTIONS

A. Bolted Connections:

1. Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ~~ASTM A325 or A490~~High Strength Bolts" for type of bolt.
2. All bolted connections, except for slip critical bolted connections, shall be tightened to snug-tight condition as specified by AISC, unless otherwise noted on Contract Drawings.

B. Slip-Critical Bolted Connections:

1. Where slip-critical bolted connections are indicated on the Contract Drawings, the faying surfaces shall be left unpainted.
2. All slip-critical bolts shall be tightened to a minimum pretension according to ~~Table 8.1 of~~ the RCSC “Specification for Structural Joints Using ~~ASTM A325 and A490~~High Strength Bolts.”

C. Welded Connections:

1. Field welds shall comply with AWS D1.1 “Structural Welding Code” for tolerance, appearances, welding procedure specifications, weld quality and methods used in correcting welding work.
2. Field welds shall be accomplished by welders certified for the weld types and positions involved. Welders in the field shall have current evidence of qualifications.

3. Weld in a manner to prevent warping or distortion of the finished product.
4. Use only shielded arc electrodes, E70xx, structural type. Low hydrogen electrodes shall be stored in strict accordance with the provisions of AWS D1.1.

D. Field-welded Moment Connections:

1. Building designed with a Seismic Response Modification Factor R = 3 (Steel Systems not specifically detailed for seismic resistance), backing bars or weld tabs required for full-penetration welds (CJP) may remain in place except when exposed to view. If backing material is removed, the weld root shall be backgouged and a reinforcing fillet weld shall be applied.
~~Building designed with a Seismic Response Modification Factor R > 3 (seismic detailing required), backing bars or weld tabs required for full-penetration welds (CJP) must be removed, the weld root backgouged and a reinforcing fillet weld shall be applied.~~

E. Welding procedure for galvanized steel:

1. Remove galvanizing from area to be welded.
2. Protect units from damage by use of non-combustible shields as required.
3. After welding, remove weld slag.
4. Touch-up area with galvanized paint.

~~Headed Shear Studs:~~

~~Shall be automatically end welded in accordance with AWS D1.1 and the manufacturer's recommendations in such a manner as to provide complete fusion between the end of the stud and the connecting material. There should be no porosity or evidence of lack of fusion between the welded end of the stud and the connecting material.~~

F. Post Installed Anchor Installation:

1. All anchors shall be installed in accordance with all the manufacturer's requirements including:

   a. Diameter of hole and method of drilling hole.

   b. Condition of hole including moisture, dust and side roughness.

   c. Temperature during installation.

2. Manufacturer's representative shall meet with Contractor's anchor installer prior to installation. Manufacturer's representative shall review procedures for anchor installation. Contractor's anchor installer shall install three (3) anchors in presence of the manufacturer's representative. Installed anchors shall be "proof loaded" to 50 percent of anchor's ultimate tension capacity. Installer shall not install anchors on project until he has successfully installed three (3) anchors that have met the "proof load" requirements in the opinion of the manufacturer's representative.
3. When installing expansion or adhesive anchors, locate the reinforcement within the concrete to avoid damaging the reinforcement during the anchor installation process. Post-installed anchors shall be located as shown on the drawings. Any changes of anchor location shall be approved by the Structural Engineer of Record (SER).

4.5 FIELD QUALITY CONTROL

A. The General Contractor shall execute proper quality control measures to ensure the structure is constructed in complete compliance with the Contract Documents. Owner-conducted testing and inspections shall be considered a quality assurance measure and shall in no way limit or decrease the contractor's own quality control program requirements. The Contractor is solely responsible for compliance with all Contract Document requirements.

B. Special Inspector/Testing Agency: Owner will engage a qualified independent testing and inspection agency and/or special inspector to perform the following inspections. Agency shall submit reports of all inspections within 48 hours of completion of inspection:

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.

C. Field Bolted Connections: Inspect bolted connections according to RCSC "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

1. Snug-Tight Bolted Connections shall be inspected to confirm that all plies of connected material have been drawn together and that the selected procedure is used to tighten all bolts. A test sample of 10% of the bolts in the connection, but not less than 2 bolts selected at random shall be tested to determine that bolts have been tightened to snug tight connection. If failed tests occur, additional bolts shall be tested.
2. Slip-Critical Bolted Connections shall be observed when installed to monitor the calibration of torqueing equipment and the installation of bolts to determine that all plies of connected materials have been drawn together and that the selected procedure is used to tighten all bolts. If inspector does not monitor the connection, all bolts in the affected connection shall be tested by using a manual torque wrench to assure that the required pretension has been reached.

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

1. Perform visual inspection of all field welds. Welds deemed questionable shall also receive non-destructive testing. Options for non-destructive testing include:

    a. Ultrasonic Inspection: ASTM E164.

    b. Radiographic Inspection: ASTM E94.

2. Multi-pass fillet welds shall be continuously inspected.
3. All field moment welds and welds associated with lateral frame assemblies shall be visually inspected and non-destructive tested. Options for non-destructive testing include:

    a. Ultrasonic Inspection: ASTM E164.

    b. Radiographic Inspection: ASTM E94.

4. All welds deemed unacceptable shall be repaired and retested at the Contractor's expense.

~~Composite Slab Shear Studs:~~

~~Shear stud quantity and layout shall be verified with the Contract Documents.~~
~~Stud weld shall be inspected. If either a less-than-continuous 360-degree flash or welding repairs to any shear connector is noted, strike all studs with a 3 pound sledge hammer with moderate force. Studs shall make a ringing sound when struck with the hammer. If a stud breaks free, or fails to make a ringing sound, further testing shall be performed as stated below.~~
~~One stud in 100 shall be tested by bending to 15 degrees from vertical, and one stud in 200 shall be tested by bending to 30 degrees from vertical. Single bent studs may be left bent.~~
~~When failure occurs during bend testing, additional bend testing shall be performed on 10 studs to either side of failed stud. Bend studs to 30 degrees from vertical. Continue testing until no failure occurs. Replace all studs that fail.~~

E. Test Post-Installed Anchors:

1. Special Inspector/Testing Agency shall randomly select 5 anchors for every 50 installed. Selected anchors shall reflect all types of installations including:

a. Overhead horizontal surfaces.

b. Vertical surfaces.

c. Sloped or skewed surfaces.

2. "Proof load" each selected anchor to 50% of the anchor's ultimate tensile capacity.
3. Architect/Engineer and Anchor Manufacturer shall be notified immediately if an anchor does not pass test requirements. Contractor shall not proceed with corrective measures without written instructions from the Structural Engineer of Record (SER) describing remedial action to be taken.

F. Special Inspector/Testing agency shall visually inspect all field welding of structural steel in accordance with the governing building code and AWS D1.1.

G. Defective Work:

1. Contractor shall be responsible for correcting deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents. Work deemed defective will be removed from the site at Contractor's expense.
2. Any special tests not covered by this specification that are proposed by the Contractor because of failure to comply with this Section shall be at the Contractor's expense. The Contractor shall be responsible for any consequential costs or delays.

4.6 REPAIRS AND PROTECTION

A. Touch-up Painting: Field bolts, field welds and abrasions to the shop coat shall be repaired and painted by the structural steel erector using the same paint and care as for shop coat. All such surfaces shall be washed with a suitable degreasing solvent. This contractor shall

also remove any and all accumulations of mud, clay, rust, scale, grease, etc. that have been acquired, for any reason, during shipment, storage and erection and the shop coat restored to its original condition.

B. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780.

C. Repair of Openings: For all members exposed to view in the final structure, close all lifting holes, access openings, etc. in such a manner that no visual evidence of the opening remains.

END OF SECTION 05 12 00

SECTION 05 31 23 - STEEL ROOF 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.

B. General Notes, Plans, Sections, Typical Details and other notes indicated on the structural drawings. In cases of conflict, information indicated on the structural drawings shall govern.

C. All Specifications and Drawings shall be examined for requirements affecting the work of this trade. Coordinate work with that of other trades.

1.2 SUMMARY

A. Section Includes: The work under this Section consists of providing all labor, materials and equipment necessary or required for the complete fabrication and erection of all Steel Roof Decking indicated on the Contract Drawings and as specified herein. Fabrication and erection shall be in accordance with the standards and specifications of the Steel Deck Institute (SDI).

B. Related Sections:

1. Section 051200 – Structural Steel Framing.
   ~~Section 052100 – Steel Joist Framing.~~
2. Section 055000 - Metal Fabrications.
   ~~Division 07 – Applied Fireproofing~~
3. Division 09 – Painting and Coatings.

1.3 QUALITY ASSURANCE

A. The following standard specifications and publications are referred to in this Section and shall govern the material, fabrication and erection of all steel roof decking:

1. ANSI/SDI RD1.0 - Standard for Steel Roof Deck
2. ANSI/SDI - QA/QC Quality Control and Quality Assurance for Installation of Steel Deck
3. SDI - Roof Deck Design Manual – No. RDDM
4. SDI - Manual of Construction with Steel Deck – No. MOC2
5. SDI - Code of Standard Practice
6. AWS D1.1 - Structural Welding Code for steel.
7. AWS D1.3 - Structural Welding Code for sheet steel.
8. AWS B2.1 - Specification for Welding Procedure and Performance Qualification.
9. AISI S-100 - Specifications for the Design of Cold Formed Steel Structural Members

B. The manufacturer shall be a current member of the Structural Deck Institute (SDI) and be certified to manufacture steel deck complying with applicable SDI standard specifications and load tables.

C. Installer shall have continuous business operation for at least 5 years, be evidence of past projects similar in complexity to this project and shall have a record of successful in-service

performance. Installer shall have sufficient well-maintained equipment to perform the work and have qualified labor to erect without delaying the project.

D. All welders in field shall hold a current and valid certificate in accordance with AWS D1.1 “Structural Welding Code” and AWS "Standard Qualification Procedure" for the type or types of welding being performed and shall have been continuously engaged in such welding.

1.4 SUBMITTALS

A. Submittal schedule, administrative and procedural requirements shall comply with Division 01, Submittal Procedures.

B. Shop Drawings: Shall be submitted to the Architect/Engineer and will be checked by the Architect/Engineer for correct interpretation and conformance of the Contract Documents. However, this check shall not relieve the General Contractor from ensuring that the shop drawings conform to the Contract Documents.

1. Resubmitted shop drawings:

a. All information which is correct on the original submittal will not be changed in any way on the resubmitted shop drawings.

b. Shop drawings that have been re-submitted will not be reviewed unless any and all revisions are “clouded”. Only “clouded” items will be reviewed.

2. Shop drawings shall be prepared in accordance with the following:

a. Dimensioned plan layout showing types of deck panels, gauge, profile and finish. Locate and dimension all shop cut openings.

b. Shop and erection details for deck anchorage (welds and fasteners), reinforcing channels, recessed sump pans, deck accessories and attachments to other construction.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store materials to permit easy access for inspection and identification. Protect from corrosion, deformation and other damage during delivery, storage and handling.

B. Stack steel decking above ground on platforms or skids with one end elevated to provide drainage. Protect with ventilated, waterproof covering to avoid condensation.

C. Do not store materials on the building structure in a manner that could cause damage or distortion to the building structure.

D. Handle material to avoid injury to persons or to avoid damage to materials in place. Any materials exhibiting damage shall be rejected and replaced as directed by the Engineer, and at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Steel Roof Deck

1. Canam Steel Corporation
2. Cordeck, Inc
3. New Millennium Building Systems
4. Nucor-Vulcraft Group

2.2 STEEL ROOF DECK

A. Fabricate steel floor deck according to ANSI/SDI RD1.0 "Standard for Steel Roof Deck." Comply with calculated structural characteristics of steel deck according to AISI "Specifications for the Design of Cold Formed Steel Structural Members."

1. Sheet steel for painted deck shall conform to ASTM A1008 with a minimum yield strength of 33 ksi, 40ksi or 80 ksi. Shop prime with manufacturer's standard baked-on, rust-inhibitive primer.
2. Sheet steel for galvanized deck shall conform to ASTM A653, Structural Quality, with a minimum yield strength of 33 ksi, 40ksi or 80 ksi, and with a coating designation of G60, unless noted otherwise.

B. Steel roof deck panels shall be continuous over as many spans as the structural steel layout will allow.

C. The vertical deflection of the steel roof deck due to the design service load shall not exceed L/240 of the span.

D. Provide 1 ½" deep – 20 ga, Grade 33 ksi Steel "Type B" wide-rib steel roof deck that complies with the following minimum requirements.

1. For a maximum deck span between supports of ~~[ ]~~5 '- 0", the total allowable uniform service load based on SDI design criteria is as follows:

a. One-span : ~~ psf~~ 105 psf

b. Two-span: ~~ psf~~ 128 psf

c. Three-span: ~~ psf~~ 159 psf

~~Provide 3" deep – 18 ga, Grade 33 ksi Steel "Type N" steel roof deck that complies with the following minimum requirements.~~

~~For a maximum deck span between supports of , the total allowable uniform service load based on SDI design criteria is as follows:~~

~~One-span: psf~~

~~Two-span: psf~~

~~Three-span: psf~~

2.3 ACCESSORIES

A. Provide manufacturer's standard accessory materials such as closures, ridge and valley plates. Sheet steel shall be 20 gauge minimum with the same yield strength and finish as the steel roof deck.

B. Provide recessed sump pans from single-piece, hot-dipped galvanized sheet steel, 14 gauge minimum, with the same yield strength as the steel roof deck. Drain holes shall be cut in the field.

C. Side-lap fasteners shall be corrosion-resistant, hexagonal washer head, self-drilling #10 carbon-steel screws (minimum).

D. Roof deck fasteners attached to support steel, in lieu of puddle weld, shall be corrosion-resistant, low-velocity, power-actuated or pneumatically-driven fasteners. #10 (minimum) self-drilling, self-threading screws are also an option. Fasteners shall meet or exceed the shear and uplift capacity provided by the specified puddle weld patterns.

E. Flexible closure strips shall be vulcanized, closed-cell or synthetic rubber.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to erection, the Contractor and installer shall examine the supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance. The Contractor shall report immediately to the Architect/Engineer in writing any condition which he finds unacceptable or that would prevent erection of the steel decking. The Contractor shall be responsible for all corrections, and all corrections shall be made in a manner acceptable to the Architect/Engineer.

B. The installer shall acquaint himself with all conditions at the site, which can affect his methods and sequence of operations. Abide by Owner's regulations concerning traffic, parking and construction material delivery.

3.2 INSTALLATION, GENERAL

A. Steel roof deck shall be placed and secured in accordance with SDI "Specifications" and with the approved shop drawing layout.

B. Do not install steel roof decking until structural support is in place, plumb and true.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels flat and square on supporting frame without warp or distortion. 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.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck. Provide additional reinforcement and closure pieces as required for strength, continuity of deck, and support of other work.

F. Suspended ceilings, light fixtures, ducts, etc. shall NOT be supported by the steel roof deck unless approved by the Architect/Engineer.

G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

H. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

I. Erection procedures shall comply with Occupational Safety and Health Administration (OSHA) “Code of Federal Regulations, Part 1926”, latest edition.

3.3 STEEL ROOF DECK INSTALLATION

A. End joints of sheets shall be lapped a minimum of 2 in. and shall occur over supports.

B. End bearing of sheets over supporting member shall be a minimum of 1 ½ inches.

C. For sloping roofs, install roof steel deck units beginning at the low side working toward the high side to insure that end laps are shingle fashion.

D. Fasten 1-1/2” “Type B” steel roof deck as follows:

1. Steel roof deck panels shall be fastened at interior panel supports and at each end panel support with arc spot (puddle) welds not less than 5/8” diameter using a 36/4 fastener pattern. Install weld washers at each weld location.

    a. As an alternate, power-actuated or pneumatically-driven fasteners may be used to fasten the steel roof deck panels to the supporting member. Fasteners shall meet or exceed the shear and uplift capacity provided by the specified 5/8" puddle weld patterns.

2. Steel roof deck panels supported at the building perimeter parallel with the deck span shall be fastened to the steel framework with arc spot (puddle) welds not less than 5/8” diameter, spaced at not more than 12 in. Install weld washers at each weld location.

    a. As an alternate, power-actuated or pneumatically-driven fasteners may be used to fasten the steel floor deck panels to the supporting member. Fasteners shall meet or exceed the shear and tension capacity provided by the specified 5/8" puddle weld pattern.

3. The side-laps of adjacent panels shall be fastened between supports with #10 (minimum) self-taping screws spaced at the one-third points of the span or 2’-0”, whichever is less.

~~Fasten 3” “Type N” steel roof deck as follows:~~

~~Steel roof deck panels shall be fastened at interior panel supports and at each end panel support with arc spot (puddle) welds not less than 5/8” diameter using a 24/4 fastener pattern. Install weld washers at each weld location.~~

~~As an alternate, power-actuated or pneumatically-driven fasteners may be used to fasten the steel roof deck panels to the supporting member. Fasteners shall~~

~~meet or exceed the shear and uplift capacity provided by the specified 5/8" puddle weld patterns.~~

~~Steel roof deck panels supported at the building perimeter parallel with the deck span shall be fastened to the steel framework with arc spot (puddle) welds not less than 5/8" diameter, spaced at not more than 8 in. Install weld washers at each weld location.~~

~~As an alternate, power-actuated or pneumatically-driven fasteners may be used to fasten the steel floor deck panels to the supporting member. Fasteners shall meet or exceed the shear and tension capacity provided by the specified 5/8" puddle weld pattern.~~

~~The side-laps of adjacent panels shall be fastened between supports with #10 (minimum) self-taping screws spaced at the one-third points of the span or 2'-0", whichever is less.~~

E. Install closures, sump pans, ridge and valley plates, and other accessories required for complete installation in accordance with the manufacturer's specifications and erection drawings. Lap all adjoining pieces 3 inches minimum.

F. Provide all required openings in the roof deck. Openings 12 in. square or larger shall be framed with structural steel per the "Typical Roof Opening Detail" on the Contract Drawings. All openings less than 12 in. wide shall be framed per the deck manufacturer's recommendations as shown on the shop drawings.

3.4 FIELD QUALITY CONTROL

A. The General Contractor shall execute proper quality control measures to ensure the structure is constructed in complete compliance with the Contract Documents. Owner-conducted testing and inspections shall be considered a quality assurance measure and shall in no way limit or decrease the contractor's own quality control program requirements. The Contractor is solely responsible for compliance with all Contract Document requirements.

B. Testing Agency: Owner will engage a qualified independent testing and inspection agency and/or special inspector to perform the following inspections. Agency shall submit reports of all inspections within 48 hours of completion of inspection.

1. Verify weld materials and inspect welds.
2. Verify spacing of welds and fasteners.

C. Defective Work:

1. Contractor shall be responsible for correcting deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents. Work deemed defective will be removed from the site at Contractor's expense.
2. Any special tests not covered by this specification that are proposed by the Contractor because of failure to comply with this Section shall be at the Contractor's expense. The Contractor shall be responsible for any consequential costs or delays.

3.5 REPAIRS AND PROTECTION

A. Touch-up Painting: Abrasions to the shop coat shall be repaired and painted by the structural steel erector using the same paint and care as for shop coat. All such surfaces shall be washed with a suitable degreasing solvent. This contractor shall also remove any and all accumulations of mud, clay, rust, scale, grease, etc. that have been acquired, for any reason, during shipment, storage and erection and the shop coat restored to its original condition.

B. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780.

END OF SECTION 05 31 23

SECTION 05 40 00 - 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.

B. General Notes, Plans, Sections, Typical Details and other notes indicated on the structural drawings. In cases of conflict, information indicated on the structural drawings shall govern.

C. All Specifications and Drawings shall be examined for requirements affecting the work of this trade. Coordinate work with that of other trades.

1.2 SUMMARY

A. Section Includes: The work under this Section consists of providing all labor, materials and equipment necessary or required for the complete fabrication and erection of all cold-formed metal framing, including connections and details, indicated on the Contract Drawings and as specified herein.

1. Non-load bearing exterior walls.
~~Load-bearing exterior and interior walls.~~
~~Pre-panelized load bearing interior and exterior walls.~~
~~Floor and roof framing assemblies.~~

B. Related Sections:

1. Section 055000 – Metal Fabrications.
2. Division 09 – Non-Structural Metal Framing.
3. Division 09 – Gypsum Board.
4. Division 09 – Gypsum Board Shaft Wall Assemblies.

~~SUSTAINABILITY REQUIREMENTS~~

~~Work performed, materials provided under this section, and construction waste management program shall comply with Division 01, LEED project requirements.~~

1.3 REFERENCES

A. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

B. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

C. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

D. ASTM A1003 – Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.

E. ASTM A1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.

F. ASTM C955 – Standard Specification for Cold-Formed Steel Structural Framing Members.

G. ASTM C1007 – Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.

H. ASCE 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures

I. AISI S100 – North American Specification for the Design of Cold-Formed Steel Structural Members.

J. AISI S200 – North American Standard for Cold-Formed Steel Framing – General Provisions.

K. AISI S202 – Code of Standard Practice for Cold-Formed Steel Structural Framing.

L. AISI S240 – North American Standard for Cold-Formed Steel Structural Framing.

M. AISI S400 – North American Standard for Seismic Design of Cold-Formed Steel Structural Systems.

N. American Welding Society (AWS).

1. AWS D1.1 – Structural Welding Code – Steel.
2. AWS D1.3 – Structural Welding Code - Sheet Steel.

1.4 PERFORMANCE REQUIREMENTS – NON-LOAD BEARING EXTERIOR WALLS

A. Structural Performance: Design cold-formed framing systems, components and connectors to withstand specified design loads in compliance with ICC (IBC), ASCE 7, AISI S100, and AISI S240:

1. Design Loads: Design loads are indicated in the “Design Criteria” of the Structural Drawings and have been determined in accordance with the ASCE 7-16 “Minimum Design Loads for Buildings and Other Structures” and the 2021 International Building Code (IBC 2021). Design loads shall be used for member, connection and anchorage design.
2. Deflection Limits: Exterior wall framing to accommodate out-of-plane horizontal deflections without regard to the contribution of the sheathing materials. Out-of-plane wall framing deflections not to exceed the following:

a. Exterior wall Framing supporting non-masonry veneer:

1) Out-of-plane horizontal deflection shall not exceed 1/360 of the wall height.

~~Exterior wall Framing supporting masonry veneer:~~

~~Out-of-plane horizontal deflection shall not exceed 1/600 of the wall height.~~

~~Wall stud members of 43 mil (18 gauge) minimum thickness.~~

3. Exterior wall framing systems to be able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
4. Exterior non-load bearing wall framing systems to be able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings:

    a. Upward and downward movement of ¾ inch (1 ½" total movement).

1.5 SUBMITTALS

A. Submittal schedule, administrative and procedural requirements shall comply with Division 01, Submittal Procedures.

B. Shop Drawings: Shop Drawings shall be submitted to the Architect/Engineer and will be checked by the Architect/Engineer for correct interpretation and conformance of the Contract Documents, however, this check shall not relieve the General Contractor from ensuring that the shop drawings conform to the Contract Documents.

1. Resubmitted shop drawings:

    a. All information which is correct on the original submittal will not be changed in any way on the resubmitted shop drawings.

    b. Shop drawings that have been re-submitted will not be reviewed unless all revisions are "clouded". Only "clouded" items will be reviewed.

2. Shop drawings shall be prepared in accordance with the following:

    a. Locations of framing members, wall framing sections and opening elevations.

    b. Sizes and spacing of framing members.

    c. Methods of fastening framing members to each other.

    d. Locations and spacing of lateral bracing and structural bracing systems.

    e. Accessory products required for complete installation.

    f. 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.

3. Design calculations for the cold-formed steel framing assemblies shall be part of the shop drawing package. Calculations, including analysis data shall be prepared by, or under the supervision of, a licensed Professional Engineer experienced in cold-formed steel design. Shop drawing and design calculations not bearing a signature and seal of a licensed Professional Engineer registered in the State where the project is located will not be accepted.
4. Informational Submittals:

    a. Manufacturer's product literature and data sheets for specified products.

    b. Welder certificates for record only, if applicable.

c. Product Test Reports: For the following:

1) Steel sheet.

2) Expansion anchors.

3) Power-actuated anchors.

4) Mechanical fasteners.

5) Vertical deflection clips.

6) Horizontal drift deflection clips.

7) Miscellaneous structural clips and accessories.

d. Research/Evaluation Reports: For cold-formed metal framing.

1) Metal stud manufacturer to have a third-party evaluation report for its products that are reviewed to the local building code or its model code (IBC 2021 and AISI S100).

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Member in good standing of the Steel Framing Industry Association (SFIA).

1. Products to be certified under an independent third-party inspection program administered by an agency accredited by IAS to ICC-ES AC98 IAS Accreditation Criteria for Inspection Agencies.

B. Engineering Responsibility: Exterior non-load bearing walls shall have shop drawings, design calculations, and other structural data prepared under the supervision of a Licensed Professional Engineer.

C. Licensed Professional Engineer Qualifications: A Professional Engineer who is legally qualified and licensed to practice in the 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. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 to conduct testing indicated.

E. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.

F. Code-Compliance Certification of Studs and Track: Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association (SFIA).

G. Welding: Qualify procedures and personnel according to AWS D1.1, “Structural Welding Code – Steel”, and AWS D2.3, “Structural Welding Code – Sheet Steel.”

H. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure."

~~Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E119 by a testing and inspecting agency acceptable to authorities having jurisdiction.~~

I. AISI Specifications and Standards: Comply with AISI's reference documents indicated in Specification Section "References."

J. Provide effective, full time quality control over all fabrication and comply with the pertinent codes and regulations of government agencies having jurisdiction.

~~Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."~~

1.7 DELIVERY, STORAGE AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling. Notify cold-formed framing manufacturer, fabricator or panelizer of damaged materials received prior to installing.

B. Store materials protected from exposure to rain, snow or other harmful weather conditions, at temperature and humidity conditions per the recommendations of ASTM C955.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cold-formed Steel Framing Manufacturers:

1. ClarkDietrich
2. MarinoWARE
3. Telling Industries
4. The Steel Network
5. CEMCO
6. SCAFCO Steel Stud Company
7. MRI Steel Framing

B. All products to be manufactured by current members of the Steel Framing Industry Association (SFIA).

~~Cold-formed Steel Panelizers / Installers:~~

~~All panelizing fabricators and pre-panelized wall installers shall have a minimum of five years of experience with the type and process of construction.~~

2.2 MATERIALS

A. Material and Product Requirements Criteria: AISI S201.

B. Steel Sheet: ASTM A1003, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Structural Grade: ST33H or ST50H, depending on framing member sheet steel thickness.
2. Corrosion Protection Coating Designation: CP60 minimum, in accordance with AISI S240.

2.3 FRAMING COMPONENTS

A. Structural Studs: Manufacturer's standard C-shaped studs, of web depths indicated, punched, with stiffened flanges, and as follow:

1. Member "web depth" and "flange width" as indicated in the Contract Documents. Provide minimum 1-5/8 inch flange width if not specified in the documents.
2. Minimum Material Thickness: Thickness shall be 43 mil (18 gauge) in thickness, unless noted otherwise in contract documents.
3. Members of 33 mil (20 Gauge) and 43 mil (18 Gauge) thickness shall be formed from ASTM A1003, Grade 33, Type H (minimum yield 33 ksi) steel.
4. Members of 54 mil (16 Gauge), 68 mil (14 Gauge), and 97 mil (12 Gauge) thickness shall be formed from ASTM A1003, Grade 50, Type H (minimum yield 50 ksi) steel.

B. Structural Track: Manufacturer's standard U-shaped steel track, of web depths indicated, un-punched, with straight flanges, and as follow:

1. Flange Width: 1 ¼ inch (32 mm) T125 flange.
2. Web: Track web depth to match stud web depth.
3. Minimum Material Thickness: Track thickness shall be 43 mil (18 gauge) in thickness, unless noted otherwise in contract documents.
4. Members of 33 mil (20 Gauge) and 43 mil (18 Gauge) thickness shall be formed from ASTM A1003, Grade 33, Type H (minimum yield 33 ksi) steel.
5. Members of 54 mil (16 Gauge), 68 mil (14 Gauge), and 97 mil (12 Gauge) thickness shall be formed from ASTM A1003, Grade 50, Type H (minimum yield 50 ksi) steel.

C. Headers and Jambs: Manufacturer's standard C and U-shapes used to form Single, Boxed or Back-to-Back Headers or Special Proprietary Shapes, of web depths indicated, un-punched, with stiffened flanges, and as follows:

1. Member "web depth" and "flange width" as indicated in the construction documents or as required by design if not specified in the documents.
2. Minimum Material Thickness: Track thickness shall be 43 mil (18 gauge) in thickness, unless noted otherwise in contract documents.
3. Members of 33 mil (20 Gauge) and 43 mil (18 Gauge) thickness shall be formed from ASTM A1003, Grade 33, Type H (minimum yield 33 ksi) steel.
4. Members of 54 mil (16 Gauge), 68 mil (14 Gauge), and 97 mil (12 Gauge) thickness shall be formed from ASTM A1003, Grade 50, Type H (minimum yield 50 ksi) steel.

D. CRC / Cold Rolled Channel Bridging: Manufacturer's standard length U-Channel for lateral bracing of exterior curtain wall framing, load bearing walls, or high interior partitions constructed of structural studs:

1. Size: 150U50-54 (1 ½" – 16 Gauge U-Channel.
2. Material: ASTM A1003, Grade 50, Type H (minimum yield 50 ksi) steel.

E. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track, un-punched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure. Install a continuous row of bridging not more than 12 inches from top of wall.

1. Member size as required by design, unless noted otherwise in the documents.

F. Vertical Deflection Clips: Manufacturer's standard clips capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web. Provide mechanical attachment to structure and screw attachment to stud web using step-bushings to permit frictionless vertical movement. 68 mil (14 Gauge) minimum thickness and size as required by structural design calculations. Use only vertical deflection connection products that have a valid ICC ES Report complying with ICC Acceptance Criteria AC261.

G. Drift Clips: Manufacturer's standard bypass or head clips capable of accommodating upward and downward vertical displacement and lateral drift of primary structure. Provide mechanical attachment to structure and screw attachment to stud web using step-bushings to permit frictionless vertical movement. 68 mil (14 Gauge) minimum thickness and size as required by structural design calculations. Use only drift clip connection products that have a valid ICC ES Report complying with ICC Acceptance Criteria AC261.

H. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

I. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws with a "low-profile" head beneath sheathing and manufacturer's standard elsewhere.

J. Touch-Up Paint: Complying with ASTM A780 "Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings."

PART 3 FABRICATION

3.1 SHOP FABRICATION – GENERAL

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting 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. Field welding of cold-formed framing elements shall not be permitted for any elements of thickness less than 68 mil (14 Gauge).

c. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no less than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable out-of-square tolerance variation of 1/8 inch in 10 feet (1:960), and in compliance with the tolerances specified in the "Tolerance" section of the specifications.

~~SHOP FABRICATION – PRE-PANELIZED STRUCTURAL WALL ASSEMBLIES~~

~~Prior to fabrication of framing, panelizing fabricator shall submit shop drawings to the Architect / Engineer to obtain approval.~~

~~Steel Stud Wall framing components shall be preassembled into wall panels in an offsite panelization facility with a stringent quality control program. Prefabricate steel stud wall panels so they are square, with components welded or screwed sufficiently to prevent racking and minimize distortion during lifting and transport. The panel facility must utilize compression jigs to fully seat all studs in the track prior to making the welded or screwed connections, and the welded or screwed connections shall be made while the panel is under compression.~~

~~Clean shop welded and abraded surfaces and repair them with a 2 mil (dry) minimum thick coating of galvanizing repair paint. Comply with manufacturer's application instructions.~~

~~All framing components shall be cut square with a tolerance of plus 0" and minus 0.125" in length.~~

~~Cut framing members by sawing or shearing, do not torch cut.~~

~~Prefabricated wall panels shall not be more than 1/8 inch out-of-square within the length of the panel and shall be in compliance with the tolerances specified in the "Tolerance" section of the specifications.~~

~~Splices in members other than top and bottom runner track are not permitted.~~

~~For metal framing indicated to receive insulation per Division 07 Section "Thermal Insulation", install full width insulation in voids which will be inaccessible after fabrication.~~

~~Reinforce, stiffen, and brace wall panels to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.~~

PART 4 EXECUTION

4.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

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

4.2 PREPARATION

A. Prepare attachment surfaces so that they are plumb, level, and in proper alignment for accepting non-load bearing and/or load bearing steel stud wall framing.

~~Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.~~

~~After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.~~

~~Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.~~

B. Install sill sealer gasket/termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

4.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed framing according to AISI's "Standard for Cold-Formed Steel Framing – General Provisions" and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install and securely anchor shop or field-fabricated cold-formed framing to supporting structure.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting 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. Field welding of cold-formed framing elements shall not be permitted for any elements of thickness less than 68 mils (14 Gauge).

c. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. 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.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation specified in Division 07 Section “Thermal Insulation”, if applicable, in built-up exterior framing assemblies such as headers, sills, boxed joists, and multiple studs at openings that are inaccessible on completion of work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

4.4 INSTALLATION – EXTERIOR NON-LOAD BEARING STRUCTURAL WALLS

A. Install continuous tracks sized as required by design. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to bottom track, unless otherwise indicated.

C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support for conditions indicated:

1. Install single deep-leg deflection track and anchor to building structure.
2. Mechanically fasten vertical deflection clips to studs and anchor to building structure.
3. Mechanically fasten drift clips to cold-formed framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings, as required by design. Fasten at each stud intersection.

1. Channel Bridging: Cold-formed steel channel welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel 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.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

~~INSTALLATION – EXTERIOR AND INTERIOR LOAD BEARING STRUCTURAL WALLS~~

~~Install continuous top and bottom tracks sized to match studs. Align tracks and securely fasten at corners and ends with a fastener spacing indicated on the Shop Drawings.~~

~~Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch between the end of wall-framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as indicated on the Shop Drawings.~~

~~Splices in load bearing wall studs are not permitted.~~

~~Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between panels not exceeding 1/16 inch.~~

~~Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar configurations.~~

~~Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.~~

~~Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.~~

~~Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.~~

~~Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of manufacturer's standard shapes indicated or required to transfer load to supporting jamb stud assembly, as required by design, complete with clip-angle connectors, web stiffeners, or gusset plates.~~

~~Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings, as required by design. Fasten at each stud intersection.~~

~~Channel Bridging: Cold-formed steel channel welded or mechanically fastened to webs of punched studs.~~
~~Strap Bridging: Combination of flat, taut, steel 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.~~
~~Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.~~

~~Lateral Bracing: Install steel sheet diagonal strap as required by design and as indicated in the Shop Drawings.~~

4.5 ERECTION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960).

B. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials

4.6 FIELD QUALITY CONTROL

A. Special Inspection for cold-formed framing: Owner to engage a qualified special inspector to perform the following special inspections:

1. Inspection of field connections.

B. Testing agency will report test results promptly and in writing to Contractor and Architect/Engineer.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

4.7 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 44 00 - COLD-FORMED METAL TRUSSES

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. General Notes, Plans, Sections, Typical Details and other notes indicated on the structural drawings. In cases of conflict, information indicated on the structural drawings shall govern.

C. All Specifications and Drawings shall be examined for requirements affecting the work of this trade. Coordinate work with that of other trades.

1.2 SUMMARY

A. Section Includes: The work under this Section consists of providing all labor, materials and equipment necessary or required for the complete fabrication and erection of all cold-formed metal framing, including connections and details, indicated on the Contract Drawings and as specified herein.

1. Light gauge cold-formed open steel roof trusses.
~~Light gauge cold-formed steel open web floor trusses.~~

B. Related Requirements:

1. Section 051200 – Structural Steel Framing
~~Section 052100 – Steel Joist Framing~~
2. Section 054000 – Cold-formed Metal Framing
3. Section 055000 – Metal Fabrications

~~SUSTAINABILITY REQUIREMENTS~~

~~Work performed, materials provided under this section, and construction waste management program shall comply with Division 01, LEED project requirements.~~

1.3 REFERENCES

A. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

B. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

C. ASTM C955 – Standard Specification for Cold-Formed Steel Structural Framing Members.

D. ASTM C1007 – Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.

E. CFSBCSI – Cold-Formed Steel Building Components Safety Information; Cold-Formed Steel Council (CFSC); latest edition with insert for Modifications to Chapters CFSB1, B2 and B3.

F. CFSEI 5000 – Field installation Guide of Cold-Formed Steel Roof Trusses.

G. AISI S100 – North American Specification for the Design of Cold-Formed Steel Structural Members.

H. AISI S200 – North American Standard for Cold-Formed Steel Framing – General Provisions.

I. AISI S202 – Code of Standard Practice for Cold-Formed Steel Structural Framing.

J. AISI S240 – North American Standard for Cold-Formed Steel Structural Framing.

K. AISI S400 – North American Standard for Seismic Design of Cold-Formed Steel Structural Systems.

L. AWS D1.1 – Structural Welding Code – Steel.

M. AWS D1.3 – Structural Welding Code – Sheet Steel.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Cold-formed steel truss design to be under the supervision of or performed by a licensed professional engineer experienced in the design of cold-formed steel trusses.

B. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: Design loads are indicated in the "Design Criteria" of the Structural Drawings and have been determined in accordance with the ASCE 7-16 "Minimum Design Loads for Buildings and Other Structures" and the 2021 International Building Code (IBC 2021). Design loads shall be used for member, connection and anchorage design.
2. Deflection Limits: Design cold-formed steel trusses to withstand design loads without deflections greater than the following:

a. Light Gauge Cold-formed Steel Roof Trusses:

1) Live Load: Vertical deflection of 1/240 of the horizontally projected span or a maximum of 1 ¾ inches.

2) Total Load: Vertical deflection of 1/180 of the horizontally projected span or a maximum of 2 inches.

~~Light Gauge Cold-formed Steel Open Web Floor Trusses:~~

~~Live Load: Vertical deflection of 1/360 of the horizontally projected span or a maximum of 1 inch.~~

~~Total Load: Vertical deflection of 1/240 of the horizontally projected span or a maximum of 1 ½ inches~~

3. Design trusses to provide for movement of truss members located outside the insulated building envelope 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 Cold-Formed Steel Framing in accordance with AISI's reference documents indicated in the Specification Section "References".

1.5 SUBMITTALS

A. Submittal schedule, administrative and procedural requirements shall comply with Division 01, Submittal Procedures.

B. Truss Submittal Package: Shop Drawings shall be submitted to the Architect/Engineer and will be checked by the Architect/Engineer for correct interpretation and conformance of the Contract Documents. However, this check shall not relieve the General Contractor from ensuring that the shop drawings conform to the Contract Documents.

1. Resubmitted shop drawings:

a. All information which is correct on the original submittal will not be changed in any way on the resubmitted shop drawings.

b. Shop drawings that have been re-submitted will not be reviewed unless all revisions are “clouded”. Only “clouded” items will be reviewed.

2. Truss Submittal Package shall include a Cover/Truss Index Sheet, Truss Placement Diagram, individual Truss Design Drawings, applicable BCSI-defined lateral restraint and diagonal bracing details, and any other structural details relevant to the cold-formed steel trusses.
3. The Truss Design Drawings shall include, at a minimum, the following information:

a. Truss Designer.

b. Building Code used for design, unless specified on Cover/Truss Index Sheet.

c. Slope or depth, span, and spacing.

d. Web member arrangement.

e. Member material properties.

f. Location of all joints and support locations.

g. Truss design loads as applicable, including:

1) Top chord live load (for Roof Trusses this shall be the controlling case of live, rain or snow load).

2) Top chord dead load.

3) Bottom chord live load.

4) Bottom chord dead load.

5) Lateral loads due to wind and seismic.

6) Top and/or bottom chord axial loads.

h. Truss member-to-member connection details and methods of fastening.

i. Maximum reaction force and direction including truss bearing and uplift connection details.

j. Calculated span to deflection ratio and/or maximum vertical and horizontal deflections.

4. Design calculations for the cold-formed steel truss shall be part of the truss submittal package. Calculations, including analysis data shall be prepared by, or under the supervision of, a licensed Professional Engineer experienced in cold-formed steel truss design. Truss submittal package and design calculations not bearing a signature and seal of a licensed Professional Engineer registered in the State where the project is located will not be accepted.

1.6 QUALITY ASSURANCE

A. Truss Fabricator Qualifications: Fabrication shall be performed by an experienced cold-formed steel truss fabricator with minimum of 5 years of experience designing and fabricating cold-formed steel truss systems equal in material, design, and extent to the systems required for this Project.

1. Fabricator to be a member of the Steel Framing Industry Association (SFIA).
2. Cold-formed steel truss installation shall be performed by an experienced installer approved by the cold-formed steel truss fabricator.
3. Qualify welding processes and welding operators in accordance with AWS “Standard Qualifications Procedure.”
4. Welding Standards shall comply with the applicable provisions in accordance with AWS D1.1 “Structural Welding Code – Steel” and AWS D1.3 “Structural Welding Code – Sheet Steel”.

B. Engineering Responsibility: Preparation of Truss Shop Drawings, design calculations, and other structural data prepared under the supervision of a Licensed Professional Engineer.

C. Licensed Professional Engineer Qualifications: A Professional Engineer who is legally qualified and licensed to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer’s unopened containers or bundles, fully identified by manufacturer's name, job name, and truss number. Exercise care to avoid damage during unloading, storing and erection. Notify truss manufacturer of damaged materials received prior to installing.

B. Recommended storage of trusses shall occur on blocking, pallets, platforms or other supports off the ground or in an upright position sufficiently braced to avoid damage from excessive bending.

C. Protect trusses and accessories from corrosion, damage and deterioration when stored at job site.

1.8 PROJECT CONDITIONS

A. During construction, adequately distribute all loads applied to trusses so as not to exceed the carrying capacity of any one truss or group of trusses.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cold-formed Steel Framing Manufacturers:

1. Aegis Metal Framing, a Division of MiTek Industries
2. Alpine TrusSteel, an ITW Company Inc.
3. Gavin Associates, Inc.
4. Atlantic Prefab Incorporated

B. All products to be manufactured by current members of the Steel Framing Industry Association (SFIA).

2.2 TRUSS COMPONENTS

A. Trusses: Light gauge steel assemblies providing a complete horizontal framing system for locations indicated, ready for deck installation.

1. Truss Type, Span, and Height: As indicated on drawings
2. Chord and Web Members: Fabricate required shapes from commercial quality galvanized steel sheet complying with ASTM A653, with minimum yield strength of 40,000 psi; minimum G60/Z180 coating; gauges as required for load conditions; all edges rolled or closed.

B. Fasteners: Self-drilling, self-tapping screw fasteners with corrosion-resistant plated finish, as recommended by steel truss manufacturer and marked for easy identification.

1. Welding: Comply with applicable provisions of AWS D1.1 and AWS D1.3.

C. Bracing, Bridging, and Blocking Members: Fabricate required shapes from commercial quality galvanized steel sheet complying with ASTM A653, with minimum yield strength of 33,000 psi; minimum G60/Z180 coating; gauges as required for load conditions.

D. Touch-Up Paint: Complying with ASTM A780 “Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings Steel Shapes and Clips: ASTM A36, zinc coated by hot-dip process according to ASTM A123.

PART 3 FABRICATION

3.1 SHOP FABRICATION - GENERAL

A. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate trusses using jigs templates.
2. Cut truss members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

4. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual truss members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel truss to a maximum out-of-square tolerance of 1/8 inch.

PART 4 EXECUTION

4.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting trusses and 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.

4.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed steel trusses without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

4.3 INSTALLATION

A. Install cold-formed steel trusses in strict accordance with manufacturer's instructions and approved shop drawings, using approved fastening methods.

B. Install temporary erection bracing and permanent bracing and bridging before application of any loads. Erect trusses with plane of truss webs vertical and parallel to each other, accurately located at spacing indicated. Anchor trusses securely at bearing points.

C. Adequately distribute applied loads to avoid exceeding the carrying capacity of any one joint, truss, or other component.

D. Exercise care to avoid damaging truss members during lifting and erection and to minimize horizontal bending of trusses.

E. Removal, cutting, or alteration of any truss chord, web, or bracing member in the field is prohibited, unless approved in advance by Architect or the structural engineer of record and the truss manufacturer.

F. Repair or replace damaged members and complete trusses as directed and approved in writing by Architect or the structural engineer of record and the truss manufacturer.

G. Galvanizing Repair: Touch up bare steel with zinc-rich paint in compliance with ASTM A780.

H. Field Welding: In accordance with AWS D1.1 and AWS D1.3, as applicable, and as follows:

1. Connections: Provide fillet, flat, plug, or butt welds, as indicated.
2. Minimum steel thickness for welded connections, 18 gauge, 0.0478 inch.

~~Open Web Floor Trusses:~~

~~Install over supporting framing with minimum end bearing of 1-1/2 inches.~~
~~Reinforce ends of trusses with web stiffeners, end clips, joist hangers, or other method as recommended by manufacturer.~~
~~Frame openings with built-up joist hangers where indicated.~~
~~Install truss reinforcement at interior supports as recommended by truss manufacturer.~~
~~Install bridging at each end of trusses and at intervals as indicated.~~
~~Secure trusses to load-bearing interior walls to prevent lateral movement of bottom flange.~~
~~Install miscellaneous framing and connections, including web stiffeners, clip angles, hold-down angles, anchors, and fasteners as required for a complete and stable floor framing assembly.~~

I. Roof Trusses:

1. Comply with recommendations of CFSEI 5000.
2. Align truss bottom chords with load-bearing studs or continuously reinforce track as required to transfer loads to structure.
3. Install continuous bridging and permanent truss bracing as indicated.
4. Install roof cross bracing and diagonal bracing as indicated.

4.4 ERECTION TOLERANCES

A. Install cold-formed steel trusses level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet.

B. Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials

4.5 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel trusses with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

4.6 FIELD QUALITY CONTROL

A. Special Inspections for cold-formed steel trusses: Owner to engage a qualified special inspector to perform the following special inspections:

1. Inspection of field connections.
2. Spans 60 Feet or Longer: Verify temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed according to the approved truss submittal package.

B. Cold-formed metal trusses will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

4.7 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel trusses are without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 44 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 2 PRODUCTS

END OF SECTION 05 50 00

SECTION 05 51 00 - METAL STAIRS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Stairs with concrete treads.

B. Structural steel stair framing and supports.

C. Handrails and guards.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete fill in stair pans; mesh reinforcement for landings.

B. Section 03 30 00 - Cast-in-Place Concrete: Placement of metal anchors in concrete.

C. Section 04 20 00 - Unit Masonry: Placement of metal fabrications in masonry.

D. Section 05 50 00 - Metal Fabrications.

1.3 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. AISC 207 - Standard for Certification Programs; 2025.

C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

D. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling; 2026a.

E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

H. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.

I. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.

J. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

K. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.

L. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

M. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi, 144 ksi, and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2025a.

N. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.

O. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021, with Errata (2023).

P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

Q. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.

R. SSPC-SP 2 - Hand Tool Cleaning; 2024.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
2. Include the design engineer's seal and signature on each sheet of shop drawings.

C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.

1.5 QUALITY ASSURANCE

A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.

PART 2 PRODUCTS

2.1 METAL STAIRS - GENERAL

A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.

1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
2. Handrails: Comply with applicable accessibility requirements of ADA Standards.
3. Structural Design: Provide complete stair and railing assemblies that comply with the applicable local code.

4. Dimensions: As indicated on drawings.
5. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
6. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
7. Separate dissimilar metals using paint or permanent tape.

B. Metal Jointing and Finish Quality Levels:

1. Service: Exposed joints tight with face surfaces aligned; underside of stair not covered by soffit is not considered exposed to view.

a. Welded Joints: Welded on back side wherever possible.

b. Welds Exposed to View: Ground smooth; not required to be flush.

c. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts or screw threads.

d. Metal Surfaces to be Painted: Sanded smooth, suitable for satin or matte finish.

2. Industrial: All joints made neatly.

a. Welded Joints: Welded on back side wherever possible.

b. Welds Exposed to Touch: Ground smooth.

c. Bolts Exposed to Touch in Travel Area: No nuts or screw threads exposed to touch.

C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.

D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.2 METAL STAIRS WITH CONCRETE TREADS

A. Jointing and Finish Quality Level: Industrial, as defined above.

B. Risers: Closed.

C. Treads: Metal pan with field-installed concrete fill.

1. Concrete Depth: 1-1/2 inches (38 mm), minimum.
2. Tread Pan Material: Steel sheet.
3. Tread Pan Thickness: As required by design; 14 gauge, 0.075 inch (1.9 mm) minimum.
4. Concrete Reinforcement: Welded wire mesh.
5. Concrete Finish: For resilient floor covering.

D. Risers: Same material and thickness as tread pans.

1. Nosing Depth: Not more than 1-1/2 inch (38 mm) overhang.
2. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch (12 mm) wide.

E. Stringers: Rolled steel channels.

1. Stringer Depth: 10 inches (250 mm).
2. End Closure: Sheet steel of same thickness as risers welded across ends.

F. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.

G. Railings: Steel pipe railings.

H. Finish: Shop- or factory-prime painted.

I. Under Side of Stair: Exposed to view, to be finished same as specified for other exposed to view surfaces.

2.3 HANDRAILS AND GUARDS

A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.

1. Outside Diameter: 1-1/4 inch (32 mm), minimum, to 1-1/2 inches (38 mm), maximum.

B. Guards:

1. Top Rails: Round pipe or tube rails unless otherwise indicated.

a. Outside Diameter: 1-1/4 inch (32 mm), minimum, to 1-1/2 inches (38 mm), maximum.

2. Infill at Pipe Railings: Pipe or tube rails sloped parallel to stair.

a. Outside Diameter: 1 inch (25 mm).

b. Material: Steel pipe or tube, round.

c. Vertical Spacing: Maximum 4 inches (100 mm) on center.

d. Jointing: Welded and ground smooth and flush.

3. End and Intermediate Posts: Same material and size as top rails.

a. Horizontal Spacing: As indicated on drawings.

b. Mounting: Welded to top surface of stringer.

2.4 MATERIALS

A. Steel Sections: ASTM A36/A36M.

B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.

C. Pipe: ASTM A53/A53M Grade B Schedule 40, black finish.

D. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.

1. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Designation CS (commercial steel).
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel).

E. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/230 with G40/Z120 coating.

F. Concrete Fill: See Section 03 30 00.

G. Concrete Reinforcement: Mesh type as detailed, galvanized.

2.5 ACCESSORIES

A. Steel Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.

B. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

C. Shop and Touch-Up Primer: SSPC-Paint 15, and comply with VOC limitations of authorities having jurisdiction.

2.6 SHOP FINISHING

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Prime Painting: Use specified shop- and touch-up primer.

1. Preparation of Steel: In accordance with SSPC-SP 2 Hand Tool Cleaning.
2. Number of Coats: One.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.2 PREPARATION

A. When field welding is required, clean and strip primed steel items to bare metal.

B. Supply items required to be cast into concrete and embedded in masonry with setting templates.

3.3 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.

B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.

C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.

E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.

F. Obtain approval prior to site cutting or creating adjustments not scheduled.

G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.4 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

END OF SECTION 05 51 00

SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 GENERAL

1.1 SECTIONS INCLUDES

A. Preservative-treated wood materials.

B. Fire-retardant-treated wood materials.

C. Wood in contact with membrane waterproofing.

D. Concealed wood blocking, nailers, and supports.

1.2 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. AWPA M4 - Standard for the Handling, Storage, Field Fabrication and Field Treatment of Preservative-Treated Wood Products; 2023.

C. AWPA U1 - Use Category System: User Specification for Treated Wood; 2025.

D. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. ITS (DIR) - Directory of Listed Products; Current Edition.

F. PS 20 - American Softwood Lumber Standard; 2025.

G. UL (DIR) - Online Certifications Directory; Current Edition.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data:

1. Fire-retardant treatment.
2. Pressure-preservative treatment.
3. Field-applied preservative treatment product data and application instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Cover wood products to protect against moisture. Support stacked products to prevent deformation and allow air circulation.

B. Fire-Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.

1. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org), and that provides grading service for species and grade specified. Provide lumber stamped with grade mark unless otherwise indicated.

2.2 DIMENSION LUMBER

A. Sizes: Nominal sizes as indicated on drawings, S4S.

B. Moisture Content: S-dry or MC19.

C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:

1. Lumber: S4S, No.2 or Standard Grade.
2. Boards: Standard or No.3.

D. Window and Door Bucks: 1-1/2 inch (38 mm) thick laminated veneer~~strand~~ lumber (LVL).

1. Comply with AWPA U1 use category 2.

2.3 FIRE-RETARDANT TREATMENT (FRT)

A. Factory-treat wood members in accordance with AWPA U1 and use category indicated.

B. Fire-Retardant Treatment: Interior Type A, Use Category UCFA (LT), Low-Temperature (low hygroscopic).

1. Treat electrical and communications panel backer boards.
2. Treat wood in locations indicated on drawings.

C. Kiln-dry after treatment (KDAT) to maximum moisture content of 19 percent for sawn material and 15 percent for plywood.

D. Fabrication of FRT Wood:

1. Ripping or milling of boards, lumber, and timber after treatment is not permitted.
2. Field cutting to length and drilling of holes in boards, lumber, and timber are permitted without additional treatment.
3. Field cutting and drilling of holes in plywood are permitted.

E. Label or brand FRT wood with classification mark of UL (DIR) or ITS (DIR) or other approved inspection agency, the treatment plant, name of treatment, species of wood, flame spread and smoke-developed indexes, method of drying after treatment, and treating standard.

2.4 PRESSURE-PRESERVATIVE TREATMENT (PPT)

A. Factory-treat wood members in accordance with AWPA U1 and use category indicated.

B. Preservative Limitations for Interior Use Categories UC1 and UC2:

C. Applications - Treat the Following:

1. Lumber and plywood in contact with waterproofing and flashing: Use Category _____.
2. Composite materials parallel strand lumber (PSL), laminated veneer lumber (LVL), and structural glued laminated timber (treated after gluing): Use Category _____.

D. Kiln-dry wood after treatment with waterborne preservative to maximum moisture content of 19 percent for lumber and 15 percent for plywood.

E. Perform fabrication such as cutting, boring, milling, and surfacing to maximum extent practicable before treatment.

F. Label preservative-treated wood with marking as required by AWPA U1 and ICC (IBC). Unless otherwise permitted by standard U1 and the building code, marking shall include the phrase: AWPA U1, accredited inspection agency's mark, and shall identify treating plant, type of preservative, retention, and end use.

G. Field Treatment for Cuts and Holes in Preservative-Treated Wood: Comply with AWPA M4.

2.5 ACCESSORIES

A. Metal and Finish of Fasteners:

1. Fire-Retardant-Treated Wood:

a. Comply with manufacturer's recomendations.

2. Preservative-Treated Wood:

a. Nails, timber rivets, wood screws, and lag screws - general use: Hot-dip galvanized steel complying with ASTM A153/A153M Class D.

3. Untreated Wood: Unfinished steel.
4. Metal and Finish: Hot-dip galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate installation of rough carpentry members specified in other sections.

3.2 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to greatest extent possible; clearly separate scrap for use on-site as accessory components, including shims, bracing, and blocking.

C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.3 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

B. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.

C. In walls, provide blocking attached to studs as backing and support for wall-mounted items unless item can be securely fastened to two or more studs or another method of support is explicitly indicated.

D. Where ceiling mounting is indicated, provide blocking and supplementary supports above ceiling unless another method of support is explicitly indicated.

E. Provide the following specific nonstructural framing and blocking:

1. Cabinets and shelf supports.
2. Wall brackets.
3. Handrails.
4. Grab bars.
5. Towel and bath accessories.
6. Wall-mounted door stops.
7. Chalkboards and marker boards.
8. Wall paneling and trim.
9. Joints of rigid wall coverings that occur between studs.

3.4 ROOF-RELATED CARPENTRY

A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.

B. Provide blocking and nailers required by roofing assembly.

C. Provide wood curb at roof openings except where prefabricated curbs are specified and where specifically indicated otherwise. Form corners by alternating lapping side members.

3.5 CLEANING

A. Waste Disposal: See Section 01 74 19 - Construction Waste Management and Disposal.

1. Comply with applicable regulations.
2. Do not burn scrap on project site.
3. Do not burn scraps that have been pressure treated.
4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

B. Do not leave wood, shavings, sawdust, etc. on ground or buried in fill.

C. Prevent sawdust and wood shavings from entering storm drainage system.

END OF SECTION 06 10 53

SECTION 06 16 00 - SHEATHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sheathing.

1.2 REFERENCE STANDARDS

A. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

B. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

C. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies; 2025.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide technical data on sheathing, wood preservative materials, and application instructions.

C. Certificate: Certify that products of this section meet or exceed specified requirements.

D. Specimen warranty.

1.4 QUALITY ASSURANCE

A. Use materials evaluated by Air Barrier Association of America (ABAA).

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Store products above ground in dry ventilated space to protect against moisture. Support stacked products to prevent deformation and allow air circulation.

C. Protect materials from soiling and damage.

D. Deliver materials to site promptly without undue exposure to weather.

E. Deliver in manufacturer’s unopened containers, pallets, or panels fully identified with name, brand, type, and grade.

F. Do not stack panels over plus or minus 1/2 inch (13 mm) off pallet edge.

1.6 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide warranty for material defects and fabrication as noted in manufacturer's documentation. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. USG Corporation~~,[___]~~: www.usg.com/#sle.

B. ~~_____.~~CertainTeed; SAINT-GOBAIN.

C. ~~[___]National Gypsum Company.~~National Gypsum Company.

D. Substitutions: See Section 01 60 00 - Product Requirements.

E. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

2.2 SHEATHING

A. Glass-mat-faced gypsum wall sheathing with integral water-resistive and air barrier, comply with ASTM C1177/C1177M.

1. Size: 48 by 96 inches (1220 by 2440 mm), nominal.
2. Thickness: 1/2 inch (12.7 mm).
3. Edges: Square.
4. Water Vapor Permeance: 1 perm (57.5 ng/(Pa s sq m)), minimum, when tested in accordance with ASTM E96/E96M.
5. Air Permeance, Sheathing: 0.001 cfm/sq ft (0.005 L/sec/sq m), maximum, when tested in accordance with ASTM E2178.
6. Air Permeance, Assembly: 0.04 cfm/sq ft (0.2 L/sec/sq m), maximum, when tested in accordance with ASTM E2357.

2.3 ACCESSORIES

A. Fasteners and Anchors:

1. General: Refer to manufacturer product information for fastener types and requirements.

B. Panel Treatment: Use manufacturer-recommended sealant, transition trips, flashing sheets, termination bars, patching materials, and adhesive tapes at control joints, panel connections, and penetrations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and adjoining construction.

3.2 INSTALLATION

A. Select material sizes to minimize waste.

B. Reuse and clearly separate scrap for use on-site as accessory components, including shims, bracing, and blocking.

C. Wall Sheathing with Integrated Water-Resistive Barrier and Air Barrier: Secure to studs in accordance with manufacturer's installation instructions.

1. Install with water-resistive and air barrier on exterior side of sheathing.
2. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
3. Do not install directly over masonry surfaces; use furring strips or framing.
4. Apply manufacturer's standard seam sealants and transition membranes.

3.3 TOLERANCES

A. Variation from Plane; Surfaces Other Than Floors: 1/4 inch (2 mm) in 10 feet (3 m), maximum, and 1/4 inch (7 mm) in 30 feet (9.1 m), maximum.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

3.5 CLEANING

A. Waste Disposal: See Section 01 74 19 - Construction Waste Management and Disposal.

1. Comply with applicable regulations.
2. Do not burn scrap on project site.
3. Do not burn pressure treated scraps.

B. Clean material debris, shavings, and sawdust prior to Substantial Completion of project.

3.6 PROTECTION

A. Cover sheathing panels by exterior cladding or other weather-resistive barrier. Do not expose panels to elements for more than 12 months after installation. If exposure anticipated past 12 months, apply joint treatments, weather-resistive barrier, or air barrier according to manufacturer's recommendations.

END OF SECTION 06 16 00

SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wood casework with laminate cladding.

B. Cabinet and drawer hardware.

1.2 REFERENCE STANDARDS

A. AWI 100 - Submittals; 2018.

B. BHMA A156.9 - Cabinet Hardware; 2020.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Shop Drawings:

1. General: Each sheet sequentially numbered and dated.

a. Sheet Size: 11 by 17 inches (280 by 430 mm).

b. Contents: Indicate project name and project address.

2. ~~AWI QCP Program~~AWI QCP Program Shop Drawing Requirements:

a. Comply with AWI 100 for shop drawing front matter documentation.

b. Cover Sheet: Include phone numbers of design and general contractor firms.

c. Table of Contents: Include page number and title of each shop drawing.

d. Aesthetic Grade: Identify specified grade and indicate compliance.

e. Performance Duty Level: Identify specified duty level and indicate compliance.

f. Identification of Materials: Include material lists or schedules.

g. Reference Plans: Casework locations in relative context of building floor plans.

1) Drawing Scale: 1/4 inch = 1 foot (1:50), minimum.

h. Plans and Elevations: Plan and elevation views of each assembly type.

1) Include rough opening dimensions and casework assembly dimensions.

2) Drawing Scale: 3/4 inch = 1 foot (1:20), minimum.

i. Detailed Sections: Dimensioned section views of each casework configuration.

1) Include appropriate locations for casework wall anchorage.

2) Drawing Scale: 1-1/2 inch = 1 foot (1:10), minimum.

j. Details: Dimensioned casework assembly details with material thicknesses.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: AWI QCP-licensed woodworking firm.

B. Installer Qualifications: AWI QC-accredited installer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in original packaging materials bearing product identification.

B. Store products prior to installation on flat, level, clean surfaces; elevate products above floors and protect from sunlight.

C. Store products in interior rooms with completed wet work and overhead work.

D. Relative Humidity Conditions for Storing Wood and Wood-Based Core Products:

1. Maintain relative humidity between 25 and 45 percent.

E. Store non-wood-based products under cover and elevated above grade.

1.6 FIELD CONDITIONS

A. Ambient Conditions for Acclimation, Installation, and Post-Installation of Wood-Based Products:

1. Acclimation Period Prior to Installation: 72 hours minimum, inside installation environment.
2. Temperature Conditions During Installation and Post-Installation: Maintain temperature between 60 degrees F (16 degrees C) and 90 degrees F (32 degrees C).

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Formica Corporation: www.formica.com/#sle.

2.2 ARCHITECTURAL WOOD CASEWORK

A. Casework Finish: Wood casework with laminate cladding.

B. Provide casework and casework components in sizes and profiles as indicated on drawings.

2.3 WOOD CASEWORK WITH LAMINATE CLADDING

A. Casework Construction:

1. Frameless Cabinet and Door Interface: Flush overlay.

B. Wood Drawer Boxes with Laminate Cladding:

C. Custom Grade - Laminate-Clad Wood Casework:

1. Exposed Exterior Surfaces, Panels to Receive Laminate Cladding:
2. Exposed Interior Surfaces at Door and Drawer Fronts:
3. Exposed Interior Surfaces Except Door and Drawer Front Surfaces:

D. Edgebanding Applications for Laminate-Clad Wood Casework:

1. Drawer Box Top Edges:

E. Edgebanding Materials for Laminate-Clad Wood Casework:

2.4 EDGE TREATMENT APPLICATIONS

A. Front Edges of Frameless Cabinets:

B. Top Edges of Cabinets:

C. Hinged Door Edges:

D. Drawer Front and Drawer False Front Edges:

2.5 CONCEALED CABINET BASE COMPONENTS

A. Cabinet Base Toe-Kick Subfronts:

B. Cabinet Base Blocking and Stretchers:

C. Cabinet Base Sleepers:

2.6 WOOD AND WOOD-BASED MATERIALS

2.7 CABINET AND DRAWER HARDWARE

A. Hinges, Number of Hinges for Each Cabinet Door:

B. Hinges, Self-Closing, Integrated Damper Hinges:

C. Cabinet Door Pulls:

D. Shelf Rests:

E. Adjustable Shelf Support Systems, Standards and Shelf Rests:

F. Drawer Slides:

1. Description: Hardware units that suspend drawers and provide controlled drawer sliding.
2. Comply with specified performance requirements.
3. Comply with BHMA A156.9, Standard Duty Grade 1.
4. Features: Self-closing.
5. Mounting: Side-mounted self-closing.
6. Travel: Full extension.
7. Material and Finish: Satin anodized aluminum.
8. Products:

G. Cabinet Door and Drawer Silencers:

1. Description: Self-adhesive rubber silencers.
2. Doors, Quantity: One silencer at top and bottom of closing edge of each door.
3. Drawers, Quantity: One silencer at back side of each drawer front cover.

2.8 CASEWORK ACCESSORY COMPONENTS

A. Glass and Glazing Applications:

B. Grommets: Plastic, with matching slotted caps; round.

2.9 FABRICATION

A. Shop-fabricate casework to dimensions, profiles, and details indicated on drawings.

B. Fabricate to maximum extents plausible, including doors, drawers, and hardware; fabricate units in sizes transportable through building openings.

C. Wood Casework with Laminate Cladding: Apply laminates in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline.

D. Edgebanding: Apply where specified; do not use more than one piece for any single length.

E. Hardware: Install hardware in accordance with hardware manufacturer's written instructions; use fasteners supplied by hardware manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify casework and materials required for installation have been delivered, handled and stored as specified.

B. Verify wood blocking that provides casework backing is installed as indicated on drawings.

C. Verify location and sizes of rough-in plumbing and rough-in electrical associated with work of this section.

3.2 INSTALLATION

A. Install and secure work of this section in accordance with specified performance requirements.

B. Install work of this section rigid, plumb, and level and in accordance with fabricator's documented instructions; secure casework as indicated on drawings.

C. Install cabinet hardware in accordance with hardware manufacturer's documented instructions using hardware manufacturer's furnished fasteners.

D. Install scribe fillers to close gaps between casework and adjacent walls.

3.3 TOLERANCES

A. Comply with specified performance requirements for tolerances.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

3.5 ADJUSTING

A. Adjust hardware for smooth operation in accordance with hardware manufacturer's documented instructions.

3.6 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

3.7 PROTECTION

A. Protect installed casework from subsequent construction operations.

SECTION 06 42 00 - WOOD PANELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Reclaimed wood paneling.

1.2 REFERENCE STANDARDS

A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.

1. Scale of Drawings: 1-1/2 inch to 1 foot (125 mm to 1 m), minimum.

C. Samples: Submit two samples of finished plywood, ____ x ____ inch (____ x ____ mm) in size, illustrating wood grain and specified finish.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.5 MOCK-UP

A. Construct mock-up, ____ feet (____ m) long by ____ feet (____ m) wide, illustrating full panel sheet, edge trim, joint trim, applied finish , and _____.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect work from moisture damage.

B. Do not deliver wood materials to project site until building is fully enclosed and interior temperature and humidity are in accordance with recommendations of AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

PART 2 PRODUCTS

2.1 PANELING

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.

B. Reclaimed Wood Paneling:

1. Naturally weathered, reclaimed wood board paneling.
2. Thickness: 3/4 inch (19 mm).
3. Beveled Thickness: 1/2 inch to 1/4 inch (12.8 mm to 6.4 mm).
4. Face Width: 4 inches (102 mm).
5. Length: ~~1 foot (305 mm)~~As indicated on drawings.
6. Species: ~~Pine~~To be selected by owner..
7. Milling Options: ~~Nickel gap~~As indicated on drawings.
8. Application: Vertical.
9. Manufacturers:

a. ~~[____]~~Timberchic; www.timerchic.com.

2.2 WOOD-BASED MATERIALS - GENERAL

A. Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless indicated otherwise, and provided it is clean and free of contamination, identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc. (ALSC).

2.3 ADHESIVES AND FASTENERS

A. Adhesives: Type suitable for intended purpose, complying with applicable air quality regulations.

B. Fasteners: Of size and type to suit application; _____ finish in concealed locations and _____ finish in exposed locations.

2.4 FABRICATION

A. Prepare panels for delivery to site, permitting passage through building openings.

B. Finish exposed edges of panels as specified by grade requirements.

2.5 ACCESSORIES

A. Metal Trim:

1. Material: Extruded aluminum.
2. Manufacturers:

a. Eagle Mouldings, Inc; _____: www.eagle-aluminum.com/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.

B. Verify adequacy of backing and support framing.

C. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.2 INSTALLATION

A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

B. Do not begin installation until wood materials have been fully acclimated to interior conditions.

C. Set and secure materials and components in place, plumb and level, using concealed fasteners wherever possible.

END OF SECTION 06 42 00

SECTION 06 64 00 - PLASTIC PANELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Plastic liner panel assemblies.

1.2 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

B. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: For each panel and trim type.

C. Shop Drawings:

1. For each wall paneling layout, indicate:

a. Elevations: Dimensioned locations of panels and penetrations. Include field measurements indicating extents of paneling.

D. Installer's qualification statement.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in manufacturer's original, unopened packaging, with labels clearly identifying product name and manufacturer.

B. Store products in clean, dry, interior areas in accordance with manufacturer's instructions.

C. Store plastic panels and trim flat.

1.6 FIELD CONDITIONS

A. Ambient Field-Cutting Conditions: Before field-cutting panels in temperatures below 40 degrees F (4.4 degrees C), warm space to 60 degrees F (16 degrees C) minimum. Maintain temperature for 24 hours before, during, and after field-cutting.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Plastic Paneling:

1. ~~[ ]~~Valto Engineered Materials: www,valtoem.com.

2.2 PLASTIC PANELING

A. Material: 100 percent virgin PVC (polyvinyl chloride), exterior grade.

B. Surface Burning Requirements, Interior Use: Flame spread index of 25 or less and smoke-development index of 450 or less; Class A classification when tested in accordance with ASTM E84.

C. Fungi Resistance: No visible growth, when tested in accordance with ASTM G21.

2.3 EMBOSSED PANELS

A. Description: Fire-X Glasbord with Surfaseal is made of fiberglass reinforced plastic, and is a durable, flexible material that will not mold, mildew, rot or corrode. It exhibits excellent resistance to mild chemicals and moisture. The panel has a Class A Fire Rating for flamespread and smoke development when tested per ASTM E-84.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrates are prepared to receive plastic paneling.

B. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify mechanical, electrical, and other building components affecting work of this section are placed and ready to receive work of this section.

3.2 INSTALLATION - GENERAL

A. Maintain manufacturer recommended gap tolerances between panels and adjacent abutments.

B. Field-cut panels in accordance with manufacturer's written instructions. Make straight and square cuts; do not damage panels.

3.3 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Clean exposed surfaces of panels and trim in accordance with manufacturer's instructions.

3.4 PROTECTION

A. Protect installed plastic paneling from subsequent construction operations.

END OF SECTION 06 64 00

SECTION 06 82 00 - COMPOSITE TRIM

PART 2 PRODUCTS

END OF SECTION 06 82 00

SECTION 07 05 43 - CLADDING SUPPORT SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cladding support systems, directly attached to substrates.

B. Cladding support systems, insulation penetrating.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry.

B. Section 07 21 00 - Thermal Insulation.

C. Section 07 25 00 - Weather Barriers.

D. Section 07 26 00 - Vapor Retarders.

E. Section 07 27 00 - Air Barriers.

1.3 REFERENCE STANDARDS

A. ASTM C1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections; 2024.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

C. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2025.

D. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate cladding support system manufacturer's requirements with requirements of exterior structural wall assemblies.

B. Preinstallation Meetings:

1. Schedule meeting to occur after final approval of submittals by Architect.
2. Agenda: Review exterior structural wall assembly requirements and cladding fastening requirements.
3. Required Attendees: Contractor, cladding support system subcontractors and cladding subcontractors.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's published descriptive data, including product attributes.

1. Include data for cladding support system.

C. Shop Drawings: For each cladding support system; indicate:

D. Manufacturer's Instructions: Submit manufacturer's written installation instructions.

E. Specimen warranty.

1.6 MOCK-UPS

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Construct exterior wall assembly mock-up, including cladding support systems as indicated on drawings.

C. Locate as indicated on drawings.

D. Mock-up may remain as part of work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Deliver products to project site in wrapped, protected, unbroken packaging with product identification labeling.

C. Store products under cover and elevated above grade.

1.8 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer's Special Warranty: Provide 10-year warranty for cladding support system components, including structural failure of components, commencing on Date of Substantial Completion. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Advanced Architectural Products, LLC; _____: www.smartcisystems.com/#sle.

B. Substitutions: See Section 01 60 00 - Product Requirements.

C. Source Limitations: Provide complete cladding support system including wall fasteners and wall anchors from single manufacturer.

2.2 PERFORMANCE CRITERIA

A. Surface Burning Characteristics: Provide cladding support systems with a flame spread index (FSI) of 25 or less, and a smoke developed index (SDI) of 450 or less, when tested in accordance with ASTM E84 or UL 723.

B. Fire Propagation Requirements of Exterior Wall Assemblies: Tested in accordance with, and comply with, the acceptance criteria of NFPA 285.

2.3 EXTERIOR WALL ASSEMBLIES WITH CLADDING SUPPORT SYSTEMS

A. ~~Cladding~~Wall Cladding: See Section ~~07 42 13~~07 46 46 #.

B. Depth of Air-Gap Cavity: As indicated on drawings.

C. Cladding Support System Applications:

1. Direct-attached-to-substrate cladding support systems.

D. Exterior Continuous Thermal Insulation:

1. See Section 07 21 00.
2. Depth of Insulation: As indicated on drawings.

E. Water-Resistive Barriers: See Section 07 25 00.

F. Vapor Retarders: See Section 07 26 00.

G. Air Barriers: See Section 07 27 00.

H. Sheathing: See Section ~~06 10 00~~06 16 00 #.

2.4 CLADDING SUPPORT SYSTEMS, DIRECTLY ATTACHED TO SUBSTRATE

A. Perforated Metal, Hat-Shaped, Cladding Attachment Rails:

2.5 CLADDING SUPPORT SYSTEMS, INSULATION PENETRATING

A. Z-Shaped, Thermally Improved Fiber-Reinforced Polymer (FRP) Girts With Steel Inserts:

1. Description: Z-shaped, FRP girts with outboard and inboard faces; reinforced with integral, continuous, zinc-coated, steel sheet inserts.
2. Attachment to Substrate: Girts penetrate continuous insulation; wall fasteners attach inboard faces of girts to steel-framed exterior wall assemblies.
3. Rigid Foam Insulation Applications:

a. Zinc-coated steel sheet splines to stabilize insulation panels.

4. Steel Inserts and Splines: Zinc-coated steel sheets.

a. Thickness: 16 gauge, 0.060 inch (1.5 mm), minimum.

5. Girt Depth: As indicated on drawings.
6. Orientation: Horizontal.
7. Rail Spacing: In accordance with Contractor-provided structural design.
8. Products:

a. Advanced Architectural Products, LLC; GreenGirt CMH System: www.greengirt.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 MATERIALS

A. Fiberglass Reinforced Polymer (FRP):

1. Polyester resin matrix with recycled materials and fire-retardant additives; reinforced with glass strand rovings for longitudinal strength and continuous strand glass mats or stitched reinforcements for transverse strength.

2.7 FABRICATION

A. Shop fabricate to greatest extent possible.

2.8 ACCESSORIES

A. Fasteners Between Claddings and Cladding Support Systems:

1. Standard self-tapping metal screws.

B. Wall Anchors:

1. Manufacturer's corrosion-resistant-coated steel wall anchors with recommended washers for anchoring cladding support systems to concrete structural wall assemblies.

C. Wall Fasteners:

1. Manufacturer's corrosion-resistant-coated steel wall fasteners for attaching cladding support systems to steel-framed structural wall assemblies.

a. Comply with ASTM C1513.

2. Cold-Formed Steel Substrates: Manufacturer's recommended self-tapping metal screws.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Verify substrates comply with contract documents, including specified tolerances, and are ready to receive work of this section.
2. Verify air barrier, wall flashing, and rigid insulation work comply with contract documents.

B. Do not commence installation until noncompliant conditions have been corrected.

3.2 PREPARATION

A. Protection of In-Place Conditions: Protect ~~air barrier~~in-place work from damage.

B. Surface Preparation:

1. Prepare substrate surfaces using methods in accordance with cladding support system manufacturer's written instructions.
2. Clean substrate surfaces before commencement of cladding support systems.

3.3 INSTALLATION

A. Installation of Cladding Support System Substrates.

B. Install cladding support systems in accordance with Contractor-provided structural design.

C. Installation of Wall Fasteners in Cold-Formed Metal Framing Wall Substrates: Install fasteners in accordance with Contractor-provided structural design.

D. Installation of cladding systems:

1. See Section 07 46 46 for installation of Fiber-Cement Siding.

3.4 TOLERANCES

A. Install cladding support systems plumb with noncumulative maximum variation of:

1. 1/4 inch in 20 feet (1 mm in 1 m).

B. Install cladding support systems level with noncumulative maximum variation of:

1. 1/4 inch in 20 feet (1 mm in 1 m).

3.5 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

3.6 PROTECTION

A. Protect installed cladding support systems from subsequent construction operations.

END OF SECTION 07 05 43

SECTION 07 11 13 - BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Bituminous dampproofing.

1.2 RELATED REQUIREMENTS

A. Section 07 21 00 - Thermal Insulation: Rigid insulation board used as protection board.

1.3 REFERENCE STANDARDS

A. ASTM D41/D41M - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing; 2011 (Reapproved 2023).

B. ASTM D1187/D1187M - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal; 1997 (Reapproved 2024).

C. ASTM D1227/D1227M - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing; 2013 (Reapproved 2024).

D. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide properties of primer, bitumen, and mastics.

C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.5 FIELD CONDITIONS

A. Maintain ambient temperatures above 40 degrees F (5 degrees C) for 24 hours before and during application until dampproofing has cured.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Karnak Corporation; _____: www.karnakcorp.com/#sle.

B. W. R. Meadows, Inc; _____: www.wrmeadows.com/#sle.

2.2 BITUMINOUS DAMPPROOFING

A. Bituminous Dampproofing: Cold-applied water-based emulsion; asphalt with mineral colloid or chemical emulsifying agent; with or without fiber reinforcement; asbestos-free; suitable for application on vertical and horizontal surfaces.

1. Asphalt-Base Emulsion for Metal Protective Coating: ASTM D1187/D1187M, Type I - Continuous water exposure within few days after drying or Type II - Continuous weather exposure after drying.

2. Emulsified Asphalt for Roofing Protective Coating: ASTM D1227/D1227M, Type II, Class 1 - Mineral colloid emulsifying agents with non-asbestos fibers.
3. VOC Content: Not more than permitted by local, State, and federal regulations.
4. Applied Thickness: 1/16 inch (1.5 mm), minimum, wet film.
5. Products:

    a. Karnak Corporation; 220 Fibered Emulsion Dampproofing: www.karnakcorp.com/#sle.

    b. W. R. Meadows, Inc; Sealmastic Emulsion Type I (spray-grade): www.wrmeadows.com/#sle.

    c. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 BITUMEN MATERIALS

A. Cold Asphaltic Type:

1. Emulsified Asphalt: ASTM D1227/D1227M, with fiber reinforcement other than asbestos, Type II, Class 1 or 2.
2. Asphalt Primer: ASTM D41/D41M, compatible with substrate.

2.4 ACCESSORIES

A. Drainage Panel: 1/4-inch (6 mm) thick formed plastic, hollowed sandwich.

B. Protection Board: Rigid insulation; see Section 07 21 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions are acceptable prior to starting this work.

B. Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of dampproofing system.

C. Verify that items penetrating surfaces to receive dampproofing are securely installed.

3.2 PREPARATION

A. Protect adjacent surfaces not designated to receive dampproofing.

B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.

C. Do not apply dampproofing to surfaces unacceptable to manufacturer.

D. Apply mastic to seal penetrations, small cracks, or minor honeycombs in substrate.

3.3 APPLICATION

A. Foundation Walls: Apply two coats of asphalt dampproofing.

1. Not less than 1.5 gal./100 sq. ft. for first coat and not Less than 1 gal./100 sq. ft. for second coat

B. Foundation Walls: Patch disturbed areas of existing dampproofing with two additional coats of dampproofing of the same generic type.

C. Perform this work in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.

D. Prime surfaces in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.

E. Prime surfaces at a rate approved by manufacturer for application indicated, and allow primer to dry thoroughly.

F. Apply bitumen with mop.

G. Apply bitumen at a temperature limited by equiviscous temperature (EVT) plus or minus 25 degrees F (14 degrees C); do not exceed finish blowing temperature for four hours.

H. Apply bitumen in one coat, continuous and uniform, at a rate of 25 sq ft/gal (0.6 sq m/L) per coat.

I. Seal items watertight with mastic, that project through dampproofing surface.

J. Place drainage panel directly over dampproofing, butt joints, and position to ensure downward drainage.

K. Scribe and cut boards around projections, penetrations, and interruptions.

END OF SECTION 07 11 13

SECTION 07 21 00 - THERMAL INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Board insulation and integral vapor retarder at cavity wall construction, perimeter foundation wall, underside of floor slabs, over roof deck, over roof sheathing, exterior wall behind _____ wall finish, and interior wall with facer providing exposed finish.

1.2 RELATED REQUIREMENTS

A. Section 07 26 00 - Vapor Retarders: Separate vapor retarder materials.

B. Section 07 27 00 - Air Barriers: Separate air barrier materials.

C. Section 07 21 19 - Foamed-in-Place Insulation: for spray-applied polyurethane foam insulation.

D. Section 09 29 00 - Gypsum Board: for sound attenuation blanket used as acousitc insulation.

1.3 REFERENCE STANDARDS

A. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

C. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2025.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

C. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

PART 2 PRODUCTS

2.1 APPLICATIONS

A. Insulation Under Concrete Slabs: Extruded polystyrene (XPS) board.

B. Insulation at Perimeter of Foundation: Extruded polystyrene (XPS) board.

C. Insulation Over Metal Stud Framed Walls, Continuous: Extruded polystyrene (XPS) carbon black board.

2.2 FOAM BOARD INSULATION MATERIALS

A. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578 with either natural skin or cut cell surfaces.

1. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
2. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
3. Type and Thermal Resistance, R-value (RSI-value): Type IV, 5.0 (0.88), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature.

B. Extruded Polystyrene (XPS) Continuous Insulation (CI) Board: Comply with ASTM C578, and manufactured using carbon black technology.

1. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
2. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
3. Type and Thermal Resistance, R-value (RSI-value): Type IV, 5.6 (0.98), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature.
4. Board Size: 48 inch by 96 inch (1220 mm by 2440 mm).
5. Board Thickness: 1-3/4 inch (44.5 mm).
6. Board Edges: Shiplap, at long edges.

END OF SECTION 07 21 00

SECTION 07 21 00 - THERMAL INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board.
2. Polyisocyanurate foam-plastic board.
3. Mineral-wool blanket.

B. Related Requirements:

1. Section 07 21 19 "Foamed-in-Place Insulation" for spray-applied polyurethane foam insulation.
2. Section 07 54 19 "Polyvinyl-Chloride (PVC) Roofing" for insulation specified as part of roofing construction.
3. Section 09 29 00 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.
4. Section 07 1 326 “ Self-Adhering Sheet waterproofing” for insulation drainage panels.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic board.
2. Polyisocyanurate foam-plastic board.
3. Mineral-wool blanket.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

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

C. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an installer that employs personnel trained and experienced in the manufacturer’s installation requirements for thermal insulation. The General Contractor shall provide additional quality-control review of insulation installation to verify that all cavities are fully filled and all gaps are sealed. Submit a written quality-control report prior to enclosing insulation within construction assemblies.

1.5 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 until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than 25 and 450 when tested in accordance with ASTM E84.

B. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; 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 listings of another qualified testing agency.

C. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

D. Thermal-Resistance Value (R-Value): R-value as indicated below in accordance with ASTM C518.

E. EPA SNAP compliant: Provide insulation compliant with current EPA SNAP requirements and Maine law including but not limited to HFC-free blowing agents.

F. Verify insulation complies with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less, except for insulation manufactured without formaldehyde.

2.2 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded Polystyrene Board Insulation, Type IV, Drainage Panels: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Chemical Company (The); Styrofoam Perimate Insulation.

b. Owens Corning; Foamular® Insul-Drain.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
5. Application: Foundation wall insulation.

B. Extruded Polystyrene Board, Type IV: ASTM C 578, Type IV, 25-psi minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Chemical Company (The); Styrofoam Square Edge Insulation.

b. Owens Corning; Foamular® 250.

c. KingSpan; GreenGuard Type IV 25 PSI Insulation Board.

2. R-Value: 5.0 per inch.
3. Application: Below slab insulation.

C. Extruded Polystyrene Board Insulation, Type VII: ASTM C578, Type VII, 60-psi minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Chemical Company (The); Styrofoam Highload 60 PSI Square Edge.

b. Owens Corning; Foamular® 600.

c. KingSpan; GreenGuard Highload 60 PSI Square Edge.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
5. Application: At thickened slabs and other locations indicated on the drawings.

2.3 POLYISOCYANURATE FOAM-PLASTIC BOARD

A. Polyisocyanurate Board, Foil Faced: ASTM C 1289, foil faced, Type I, Class 1 or 2.

1. Manufacturers: Basis of Design: Rmax, Inc. or subject to compliance with requirements, provide products by one of the following:

a. Atlas Roofing Corporation.

b. Dow Chemical Company (The).

c. Hunter Panels.

2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
3. R-Value: 6.7 per inch.
4. Seams: All seams to be taped with compatible aluminum tape.

2.4 MINERAL-WOOL BLANKETS

A. Mineral-Wool Blanket, Unfaced: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Roxul Inc.; Rockwool Comfortbatt.

b. Thermafiber Inc.; an Owens Corning Company; Ultrabatt Insulation.

2. R-Value: 4.2 per inch.
3. Application: Interior stud cavity of exterior walls. Provide wire clips to hold insulation in place max 24” o/c.

2.5 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

B. Insulation Support Anchors: Continuous, galvannealed metal support strip, 0.032 inch (20 gage) thickness by 1 inch wide, with approximately 2 1/2 inch long pre-punched arrow shaped tabs at 8 inches on center.

2.6 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, minimal expanding, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Insulation for Exterior Hollow Metal Door Frames:

1. Polyurethane Pour-In-Place Insulation: Closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84, specifically formulated for pour-in-place applications.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

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. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

A. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. Extend insulation from exterior wall to exterior wall.

3.4 INSTALLATION OF FOUNDATION/FROST WALL INSULATION

A. On vertical foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation to footing.

B. Butt panels together for tight fit.

3.5 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.

1. Fit courses of insulation between Z furring and other obstructions, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.
3. Fill any voids or gaps between insulation boards with minimal-expanding spray foam. After curing, trim excess foam flush with the insulation surface prior to application of joint tape.
4. Tape all seams with manufacturer’s recommended tape and primer.
5. Through Wall Flashing: Where through-wall flashing penetrates foam-plastic insulation, cut insulation boards to match the angle of the flashing on both the upper and lower surfaces to maintain continuous insulation and maximize thermal performance. Cuts shall be smooth, consistent, and uniform. Hand-cutting of insulation is not permitted.

3.6 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Support unfaced blankets mechanically with insulation support anchors.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.7 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.

1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
2. Install insulation to fit snugly without bowing.

3.8 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 07 21 00

SECTION 07 21 19 - FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Foamed-in-place insulation.

1. In exterior wall crevices.
2. At junctions of dissimilar wall and roof materials.

B. Protective intumescent coating.

1.2 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

C. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

D. FM 4880 - Examination Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials; 2022.

E. NFPA 275 - Standard Method of Fire Tests for the Evaluation of Thermal Barriers; 2022.

F. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth; 2024.

G. UL 1040 - Standard for Safety Fire Test of Insulated Wall Construction; Current Edition, Including All Revisions.

H. UL 1715 - Standard for Safety Fire Test of Interior Finish Material; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.

C. ABAA Field Quality Control Submittals: Submit third-party reports of testing and inspection as required by ABAA QAP.

D. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

E. Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.

F. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer

certification on site during and after installation. Present on-site documentation upon request.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience, and approved by manufacturer.

1.5 FIELD CONDITIONS

A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.

B. Do not apply foam when temperature is within 5 degrees F (2.78 degrees C) of dew point.

PART 2 PRODUCTS

2.1 MATERIALS

A. Foamed-In-Place Insulation: Low-density, flexible, open cell or closed cell, water vapor permeable polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.

1. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.

a. Fire Protection: Provide 15-minute thermal barrier of 1/2 inch (12.7 mm) gypsum board or equivalent material complying with NFPA 275 test method, or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715.

2. Thermal Resistance: R-value (RSI-value) of 3.0 (0.53), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature when tested in accordance with ASTM C518.
3. Air Permeance: 0.04 cfm per square foot (0.2 L/(s/sq m)), maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf (75 Pa).
4. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.

2.2 ACCESSORIES

A. Primer: As required by insulation manufacturer.

B. Protective Coating: Intumescent coating of type recommended by insulation manufacturer and as required to comply with applicable codes.

1. Coating Type: Single component, water-based.
2. Protected Insulation Type: Spray polyurethane foam (SPF).
3. Application: Apply using brush, roller, or airless sprayer.
4. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.

5. Color: Gray.
6. Products:
    a. International Fireproof Technology Inc; DC315 Intumescent Coating: www.painttoprotect.com/#sle.
    b. International Coatings Group; FBL-100 Fire Barrier Latex: www.internationalcoatingsgroup.com/#sle.
    c. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify work within construction spaces or crevices is complete before insulation application.

B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation adhesion.

3.2 PREPARATION

A. Mask and protect adjacent surfaces from over spray or dusting.

B. Apply primer in accordance with manufacturer's instructions.

3.3 APPLICATION

A. Apply insulation in accordance with manufacturer's instructions.

B. Apply insulation by spray method, to a uniform monolithic density without voids.

C. Apply protective coating monolithically, without voids, to fully cover foam insulation, to achieve fire rating required.

D. Patch damaged areas.

E. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.

F. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Field inspections and tests will be performed by an independent testing agency.

C. Inspection will include verification of insulation and protective coating thickness and density.

3.5 PROTECTION

A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION 07 21 19

SECTION 07 27 00 - AIR BARRIERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air barriers.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Air barrier under exterior cladding.

B. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal flashings installed in conjunction with air barriers.

1.3 DEFINITIONS

1.4 REFERENCE STANDARDS

A. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).

B. ASTM D751 - Standard Test Methods for Coated Fabrics; 2019.

C. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds; 1998 (Reapproved 2025).

D. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2025.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

F. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

G. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

H. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2025.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on material characteristics, performance criteria, limitations, and _____.

C. Shop Drawings: Provide drawings of special joint conditions.

D. Manufacturer's qualification statement.

E. Installer's qualification statement.

1.6 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

PART 2 PRODUCTS

2.1 AIR BARRIER MATERIALS (AIR IMPERMEABLE AND WATER VAPOR IMPERMEABLE)

A. Air and Vapor Barrier Sheet, Self-Adhered:

1. Air Permeance: 0.004 cfm/sq ft (0.02 L/(s sq m)), maximum, when tested in accordance with ASTM E2178.
2. Water Vapor Permeance: 0.1 perms (5.72 ng/(Pa s sq m)), maximum, when tested in accordance with ASTM E96/E96M using Procedure B - Water Method.
3. Water Penetration Resistance Around Nails: Pass, when tested in accordance with ASTM D1970/D1970M (modified).
4. Ultraviolet (UV) and Weathering Resistance: Approved in writing by manufacturer for up to ~~30 days~~120 days of weather exposure.
5. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A when tested in accordance with ASTM E84.
6. Complies with NFPA 285 requirements for wall assembly.
7. Seam and Perimeter Tape: As recommended by sheet manufacturer.
8. Products:

a. Carlisle Coatings and Waterproofing, Inc; Fire Resist 705 FR-A XLT (Xtra Low Temperature): www.carlisleccw.com/#sle.

b. GCP Applied Technologies; Perm-A-Barrier NPS: www.gcpat.com/#sle.

c. Henry, a Carlisle Company; Metal Clad 705FR: www.henry.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 ACCESSORIES

A. Sealants, Tapes, and Accessories for Sealing Air Barrier and Adjacent Substrates: As indicated or in compliance with air barrier manufacturer's installation instructions.

B. Sealant for Cracks and Joints In Substrates: Resilient elastomeric joint sealant compatible with substrate and air barrier materials.

1. Application: Apply at 30 to 40 mil, 0.030 to 0.040 inch (0.76 to 1.02 mm), nominal thickness.
2. Color: Green.
3. Elongation: 1,300 percent, measured in accordance with ASTM D412.
4. Peel Adhesion: 28 lb/inch (5.0 kg/cm), minimum, when tested in accordance with ASTM D903.
5. Hydrostatic Head Pressure: Resists head pressure of 57 feet (17.4 m), maximum, when tested in accordance with ASTM D751.
6. Comply with NFPA 285 requirements for wall assembly.

C. Primer: Liquid applied polymer.

1. Color: Green.
2. Elongation: 1,300 percent, measured in accordance with ASTM D412.

D. Foil-Faced Self-Adhering Flashing: Membrane consisting of cross-laminated high-density polyethylene facer laminated to ultraviolet (UV) and weather-resistant exterior aluminum foil facer, using nonasphaltic, butyl-based adhesive to self-adhere to substrate.

1. Thickness: 45 mil, 0.045 inch (1.14 mm), minimum.
2. Roll Size: 50 feet (15.2 m) long by 4 inches (102 mm) wide.
3. Tensile Strength: 400 psi (2.76 MPa), minimum, complying with ASTM D412.

E. Threshold Flashing: Closed-cell foam tape with rubberized adhesive membrane; seals subfloor under threshold.

1. Width: 5-1/2 inches (140 mm).
2. Ultraviolet (UV) and Weathering Resistance: Approved by manufacturer for up to 30 days of weather exposure.

F. Seam and Perimeter Tape: Polyethylene face material with acrylic adhesive.

1. Thickness: 3.6 mils, 0.0036 inch (0.091 mm).

G. Thinners and Cleaners: As recommended by material manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and conditions are ready for work of this section.

B. Where existing conditions are responsibility of another installer, notify Architect of unsatisfactory conditions.

C. Do not proceed with this work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

B. Clean and prime substrate surfaces to receive adhesives and sealants in accordance with manufacturer's installation instructions.

3.3 INSTALLATION

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

B. Air Barriers: Install continuous airtight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.

C. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.

D. Self-Adhered Sheets:

1. Prepare substrate in accordance with sheet manufacturer's installation instructions; fill and tape joints in substrate and between dissimilar materials.
2. Lap sheets shingle fashion to shed water and seal laps airtight.
3. Once sheets are in place, press firmly into substrate with resilient hand roller; ensure that laps are firmly adhered with no gaps or fishmouths.
4. Use same material, or other material approved by sheet manufacturer, to seal to adjacent substrates, and as flashing.
5. At wide joints, provide extra flexible membrane allowing joint movement.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements

B. Coordination of ABAA Tests and Inspections:

1. Provide testing and inspection required by ABAA QAP.
2. Notify ABAA in writing of schedule for air barrier work, and allow adequate time for testing and inspection.
3. Cooperate with ABAA testing agency.
4. Allow access to air barrier work areas and staging.
5. Do not cover air barrier work until tested, inspected, and accepted.

C. Do not cover installed air barriers until required inspections have been completed.

D. Obtain approval of installation procedures from air barrier manufacturer based on a mock-up installed in place, prior to proceeding with remainder of installation.

E. Take digital photographs of each portion of installation prior to covering up air barriers.

3.5 PROTECTION

A. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION 07 27 00

SECTION 07 31 13 - ASPHALT SHINGLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Asphalt shingle roofing.

B. Flexible sheet membranes for eave protection, underlayment, and valley protection.

C. Flashing.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Roof sheathing.

B. Section 07 21 00 - Thermal Insulation: Nailable rigid insulation.

C. Section 07 62 00 - Sheet Metal Flashing and Trim: Edge and cap flashings.

D. Section 07 71 23 - Manufactured Gutters and Downspouts.

E. Section 07 72 00 - Roof Accessories: Snow guards.

1.3 REFERENCE STANDARDS

A. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2025.

B. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2025.

C. ASTM D3161/D3161M - Standard Test Method for Wind Resistance of Steep Slope Roofing Products (Fan-Induced Method); 2020 (Reapproved 2025).

D. ASTM D3462/D3462M - Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules; 2025.

E. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement; 2025.

F. ASTM D4869/D4869M - Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing; 2016a (Reapproved 2025).

G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

H. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings; 2025.

I. ASTM F1667/F1667M - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples; 2021a.

J. ICC-ES AC188 - Acceptance Criteria for Roof Underlayments; 2023.

K. NRCA (RM) - The NRCA Roofing Manual; 2026.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating material characteristics, performance criteria, limitations, and _____.

C. Shop Drawings: For metal flashings, indicate specially configured metal flashings, jointing methods and locations, fastening methods and locations, installation details, and _____.

D. Manufacturer's Installation Instructions: Indicate installation criteria and procedures.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Manufacturer's qualification statement.

G. Installer's qualification statement.

H. Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements for additional provisions.
2. Extra Shingles: ~~[____] sq ft ([____] sq m)~~100 sq ft (9 sq m) of each type, ~~and~~ color and blend, in unbroken bundles, minimum.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of roofing systems similar to those required for this project, with not less than 5 years of documented experience.

B. Installer Qualifications: Company specializing in installing asphalt shingles, with at least 3 years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Deliver and store materials with labels intact in manufacturer's unopened packaging until ready for installation.

C. When storing roofing materials on roofing system ensure no damage occurs to supporting members and other materials.

1.7 FIELD CONDITIONS

A. Do not install shingles, ~~eave protection membrane, underlayment, or [____]~~eave protection membrane or underlayment when ~~surface, ambient air, wind chill, or [____]~~surface, ambient air, or wind chill temperatures are below 45 degrees F (7 degrees C).

1.8 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Provide lifetime manufacturer's warranty for coverage against black streaks caused by algae.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Asphalt Shingles:

1. CertainTeed Roofing~~; Landmark PRO Solaris~~; Landmark PRO: www.certainteed.com/#sle.
2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 ASPHALT SHINGLES

A. Asphalt Shingles: Asphalt-coated glass felt, mineral granule surfaced, complying with ASTM D3462/D3462M.

1. Fire Resistance: Class A, complying with ASTM E108.
2. Algae resistant.
3. Self-sealing type.
4. Style: ~~Square~~Architectural.
5. Color: As selected by Architect.

2.3 SHEET MATERIALS

A. Eave Protection Membrane:

1. Eave Protection Membrane: Self-adhering polymer-modified asphalt sheet complying with ASTM D1970/D1970M; 40 mil (1 mm) total thickness; with strippable treated release paper and polyethylene sheet top surface.
2. Products:

a. _____.

b. Substitutions: See Section 01 60 00 - Product Requirements.

B. Eave Edge Starter Shingles: Glass felt base, with ceramic coated mineral granules tightly embedded in refined, water-resistant asphalt, complying with ASTM D3462/D3462M.

1. Shingle Size: 8-3/16 by 38-1/4 inches (208 by 972 mm), nominal.
2. Application: Roof with slope greater than 2 inches per foot (51 mm per 305 mm) and shingle exposure less than 5-5/8 inches (143 mm).
3. Products:

a. CertainTeed Roofing; SwiftStart Starter Shingles: www.certainteed.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

C. Underlayment: Self-adhering, rubber-modified asphalt sheet complying with ASTM D1970/D1970M; with strippable release film and woven polypropylene sheet top surface.

1. Minimum Requirements: Comply with ICC-ES AC188.
2. Thickness: 40 mils, 0.040 inch (1.01 mm).

3. Top Surface: Polyethylene film.
4. Self Sealability: Passing nail sealability test specified in ASTM D1970/D1970M.
5. Low Temperature Flexibility: Passing test specified in ASTM D1970/D1970M.
6. Water Vapor Permeance: 0.067 perm (0.38 ng/(Pa s sq m)), when tested in accordance with ASTM E96/E96M, Procedure A (desiccant method).
7. Performance: Meet or exceed requirements for ASTM D226/D226M, Type II asphalt-saturated organic felt.
8. Liquid Water Transmission: Passes ASTM D4869/D4869M.
9. Functional Temperature Range: From minus 70 degrees F (minus 56.7 degrees C) to 212 degrees F (100 degrees C).
10. Products:

    a. CertainTeed Roofing; Vycor Select: www.certainteed.com/#sle.

    b. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 FLASHING

A. Metal Flashings: Provide sheet metal eave edge, gable edge, ridge, ridge vents, open valley flashing, chimney flashing, dormer flashing, and other flashing as indicated.

1. Form flashings to profiles indicated on drawings.
2. Form sections square and accurate to profile, in maximum possible lengths, free from distortion or defects detrimental to appearance or performance.
3. Hem exposed edges of flashings minimum 1/4 inch (6 mm) on underside.

2.5 ACCESSORIES

A. Roofing Nails: Standard round wire shingle type, galvanized steel, stainless steel, aluminum roofing nails, or copper roofing nails, minimum 3/8-inch (9.5 mm) head diameter, 12-gauge, 0.109-inch (2.77 mm) nail shank diameter, 1-1/2 inches (38 mm) long and complying with ASTM F1667/F1667M.

B. Asphalt Roof Cement: ASTM D4586/D4586M, asbestos-free.

C. Lap Cement: Fibrated cutback asphalt type, recommended for use in application of underlayment, free of toxic solvents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions prior to starting this work.

B. Verify roof deck is of sufficient thickness to accept fasteners.

C. Verify roof penetrations and plumbing stacks are in place and flashed to deck surface.

D. Verify roof openings are correctly framed.

E. Verify deck surfaces are dry, free of ridges, warps, or voids.

3.2 PREPARATION

A. Seal roof deck joints wider than 1/16 inch (1.5 mm) as recommended by shingle manufacturer.

B. At areas where eave protection membrane is to be adhered to substrate, fill knot holes and surface cracks with latex filler.

C. Broom clean deck surfaces before installing underlayment or eave protection.

D. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

E. Install eave edge flashings tight with fascia boards, weather lap joints 2 inches (50 mm) and seal with roof cement, and secure flange with nails spaced ____ inches (____ mm) on center.

3.3 INSTALLATION

A. Eave Protection Membrane:

1. Install eave protection membrane from eave edge to minimum 48 inches (1,220 mm) up-slope beyond interior face of exterior wall.
2. Install eave protection membrane in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.

B. Underlayment:

1. Roof Slopes Up to 4:12: Install two layers of underlayment over area not protected by eave protection, with ends and edges weather lapped minimum 4 inches (100 mm); stagger end laps of each consecutive layer and nail in place.
2. Roof Slopes Greater Than 4:12: Install underlayment perpendicular to slope of roof, with ends and edges weather lapped minimum 4 inches (100 mm); stagger end laps of each consecutive layer, nail in place, and weather lap minimum 4 inches (100 mm) over eave protection.
3. Weather lap and seal watertight with plastic cement any items projecting through or mounted on roof.

C. Valley Protection:

1. Weather lap joints minimum 2 inches (50 mm).
2. Nail in place minimum 18 inches (450 mm) on center, 1 inch (25 mm) from edges.

D. Metal Flashing:

1. Install flashings in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
2. Weather lap joints minimum 2 inches (50 mm) and seal weather tight with plastic cement.
3. Secure in place with nails at ____ inches (____ mm) on center, and conceal fastenings.
4. Items Projecting Through or Mounted on Roofing: Flash and seal weather tight with plastic cement.

E. Shingles:

1. Install shingles in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
    a. Fasten individual shingles using two nails per shingle, or as required by manufacturer and local building code, whichever is greater.
    b. Fasten strip shingles using four nails per strip, or as required by manufacturer and local building code, whichever is greater.
2. Place shingles in straight coursing pattern with 5-inch (125 mm) weather exposure to produce double thickness over full roof area, and provide double course of shingles at eaves.
3. Project first course of shingles 3/4 inch (19 mm) beyond fascia boards.
4. Extend shingles 1/2 inch (13 mm) beyond face of gable edge fascia boards.
5. Extend shingles on both slopes across valley in a weave pattern and fasten; extend shingles a minimum of 12 inches (300 mm) beyond valley center line to achieve woven valley, concealing valley protection.
6. After installation, place one daub of plastic cement 1-inch (25.4 mm) diameter under each individual shingle tab exposed to weather to prevent lifting.
7. Coordinate installation of roof mounted components or work projecting through roof with weathertight placement of counterflashings.
8. Complete installation to provide weathertight service.

3.4 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Clean exposed work upon completion of installation; remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to finish.

3.5 PROTECTION

A. Do not permit traffic over finished roof surface; protect roofing until completion of project.

B. Touch-up, repair, or replace damaged asphalt shingles or accessories before Date of Substantial Completion.

END OF SECTION 07 31 13

SECTION 07 41 13 - METAL ROOF PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal roof panel system of preformed aluminum panels.

1.2 RELATED REQUIREMENTS

A. Section 05 12 00 - Structural Steel Framing: Roof framing and purlins.

B. Section 07 21 00 - Thermal Insulation: Rigid roof insulation.

1.3 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.

B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

C. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2025.

D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

E. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2025.

F. ICC-ES AC188 - Acceptance Criteria for Roof Underlayments; 2023.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Summary of test results, indicating compliance with specified requirements.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Specimen warranty.

C. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.

1. Show work to be field-fabricated or field-assembled.

D. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches (305 mm) square, representing actual roofing metal, thickness, profile, color, and texture.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

G. Test Reports: Indicate compliance of metal roofing system to specified requirements.

H. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.5 QUALITY ASSURANCE

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Provide strippable plastic protection on prefinished roofing panels for removal after installation.

C. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.7 FIELD CONDITIONS

A. Do not install metal roof panels, eave protection membrane, underlayment, or _____ when surface, ambient air, or wind chill temperatures are below 45 degrees F (7 degrees C).

1.8 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Architectural Metal Roof Panel Manufacturers:

1. ATAS International, Inc; Colonial Seam: www.atas.com/#sle.
2. Englert, Inc; A1300: www.englertinc.com/#sle.
3. Metl-Span, a Nucor Company; ____: www.metlspan.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS

A. Metal Roof Panels: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for compliance with the following minimum standards:

1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed L/180 of span length(L) when tested in accordance with ASTM E1592.
2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.

3. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F (56 degrees C).

2.3 METAL ROOF PANELS

A. Metal Roof Panels: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.

B. Metal Panels: Factory-formed panels with factory-applied finish.

1. Aluminum Panels:

a. Alloy and Temper: Aluminum complying with ASTM B209/B209M; temper as required for forming.

b. Thickness: Minimum 20 gauge, 0.032 inch (0.81 mm).

2. Profile: Standing seam, with minimum 1-inch (25.4 mm) seam height; concealed fastener system for field seaming with special tool.
3. Texture: Smooth.
4. Length: Full length of roof slope, without lapped horizontal joints.
5. Width: Maximum panel coverage of 36 inches (914 mm).

2.4 ATTACHMENT SYSTEM

A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.5 FABRICATION

A. Panels: Provide factory or field fabricated panels with applied finish and accessory items, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.

2.6 FINISHES

A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch (0.023 mm); color and gloss as selected by Architect from manufacturer’s standard line.

2.7 ACCESSORIES

A. Miscellaneous Sheet Metal Items: Provide ~~flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs~~flashings, gutters, downspouts, trim, moldings, closure strips, and caps of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.

B. Rib and Ridge Closures: 1 inch (25.4 mm) high, narrow batten, close-fitting cap of steel with corrosion resistant finish, closed-cell synthetic rubber, neoprene, or PVC, combination steel and closed-cell foam, copper, or prefinished aluminum.

C. Sealants:

1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
2. Concealed Sealant: Non-curing butyl sealant or tape sealant.

D. Underlayment: Self-adhering polymer modified asphalt sheet complying with ASTM D1970/D1970M, with strippable release film and top surface of woven polypropylene sheet.

1. Minimum Requirements: Comply with requirements of ICC-ES AC188 for non-self-adhesive sheet.
2. Sheet Thickness: 22 mils, 0.022 inch (0.55 mm), minimum.
3. Self Sealability: Nail sealability in accordance with ASTM D1970/D1970M.
4. Low Temperature Flexibility: Comply with ASTM D1970/D1970M.
5. Water Vapor Permeance: 0.1 perm (5.72 ng/Pa s sq m), maximum, when tested in accordance with ASTM E96/E96M using Desiccant Method (Method A).
6. Functional Temperature Range: Minus 45 degrees F (Minus 42.8 degrees C) to 250 degrees F (121 degrees C).
7. Products:

a. Certainteed Roofing; WinterGuard HT - High Temperature Waterproofing Underlayment: www.certainteed.com/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Broom clean wood sheathing prior to installation of roofing system.

B. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to ensure that completed roof will be free of leaks.

C. Remove protective film from surface of roof panels immediately prior to installation; strip film carefully to avoid damage to prefinished surfaces.

D. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by metal roof panel manufacturer.

E. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

F. At locations where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.3 INSTALLATION

A. Overall: Install roofing system in accordance with approved shop drawings and metal roof panel manufacturer's instructions and recommendations, as applicable to specific project conditions; securely anchor components of roofing system in place allowing for thermal and structural movement.

1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
2. Minimize field cutting of panels. Where field cutting is required, use methods that will not distort panel profiles. Use of torches for field cutting is prohibited.

B. Accessories: Install necessary components that are required for complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.

C. Roof Panels: Install metal roof panels in accordance with manufacturer's installation instructions, minimizing transverse joints except at junction with penetrations.

1. Install sealant or sealant tape at end laps and side joints as recommended by metal roof panel manufacturer.

3.4 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.5 PROTECTION

A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.

B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

END OF SECTION 07 41 13

SECTION 07 46 46 - FIBER-CEMENT SIDING

PART 2 PRODUCTS

1.1 FIBER-CEMENT SIDING

A. Lap Siding: Individual horizontal boards made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186, Type A, Grade II; with machined edges, for nail attachment.

1. Style: Standard lap style.
2. Texture: Smooth.
3. Length: 12 feet (3.7 m), nominal.
4. Width (Height): 5-1/4 inches (133 mm).
5. Thickness: 5/16 inch (8 mm), nominal.
6. Finish: Unfinished.
7. Color: As selected by Architect from manufacturers full range of available colors.
8. Warranty: 50 year limited; transferable.
9. Products:

a. James Hardie Building Products, Inc; _____: www.jameshardie.com/#sle.

B. Panel Siding: Vertically oriented panels made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186, Type A, Grade II; with machined edges, for nail attachment.

1. Length (Height): 96 inches (2400 mm), nominal.
2. Width: 48 inches (1220 mm).
3. Thickness: 5/16 inch (8 mm), nominal.
4. Finish: Factory applied stain.
5. Warranty: 50 year limited; transferable.

C. Plank Siding: Plank boards comprised of cement, mineral fillers, cellulose and nontoxic fibers, with through-colored construction, complying with ASTM E84, ASTM E136 and NFPA 285, Type A; with both face-fastening and concealed mechanical fastening systems.

1.2 ACCESSORIES

A. Trim: Same material and texture as siding.

B. Fasteners: Galvanized or corrosion resistant; length as required to penetrate, 1-1/4 inches (31.8 mm), minimum.

END OF SECTION 07 46 46

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fabricated sheet metal items, including flashings, counterflashings, gutters, downspouts, exterior penetrations, and other items indicated in Schedule.

B. Sealants for joints within sheet metal fabrications.

1.2 REFERENCE STANDARDS

A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.

B. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

C. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

E. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2025.

F. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement; 2025.

G. CDA A4050 - Copper in Architecture - Handbook; Current Edition.

H. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

C. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.1 SHEET MATERIALS

A. Anodized Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 0.032 inch (0.81 mm) thick; clear anodized finish.

1. Color Anodized Finish: AAMA 611, AA-M12C22A42/44, Class I, integrally or electrolytically colored anodic coating not less than 0.7 mil, 0.0007 inch (0.018 mm) thick.

a. Color: As selected by Architect from manufacturer's standard colors.

B. Stainless Steel: ASTM A666/A666M, Type 304 alloy, soft temper, 28 gauge, 0.0156 inch (0.40 mm) thick; smooth No. 4 - Brushed finish.

2.2 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest possible lengths.

C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.

D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

E. Fabricate corners from one piece with minimum 18-inch (450 mm) long legs; seam for rigidity, seal with sealant.

F. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel. Return and brake edges.

2.3 FLASHING

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.4 ACCESSORIES

A. Fasteners: ~~Galvanized steel~~Same material and finish as flashing metal, with soft neoprene washers.

B. Underlayment: ASTM D226/D226M, organic roofing felt, Type I, No. 15.

C. Slip Sheet: Rosin-sized sheathing paper.

D. Primer Type: Zinc chromate.

E. Concealed Sealants: Non-curing butyl sealant.

F. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.

G. Fenestration Perimeter Flashing Attachments: Two-piece flashing receiver and clip of extruded aluminum, at least 0.045 inch (1.14 mm) thick, for attaching flashing at perimeter of exterior wall fenestration openings.

1. Provide flashing receiver profile appropriate for flashing applications.

H. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.2 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.38 mm).

3.3 INSTALLATION

A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.

B. Apply plastic cement compound between metal flashings and felt flashings.

C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

D. Exterior Flashing Receivers: Install in accordance with manufacturer's recommendations, and in proper relationship with adjacent construction, and as follows:

E. Seal metal joints watertight.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for field inspection requirements.

B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION 07 62 00

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Roof curbs.

B. Snow guards.

1.2 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

D. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs; 2024.

E. FM (AG) - FM Approval Guide; Current Edition.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used.

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Maintenance requirements.

C. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.

1. Snow Guards: Submit design calculations for loadings and spacings based on manufacturer testing.

D. Warranty Documentation:

1. Submit manufacturer warranty.
2. Ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products under cover and elevated above grade.

1.5 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for _____. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 ROOF CURBS

A. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.

1. Roof Curb Mounting Substrate: Curb substrate consists of standing seam metal roof panel system.
2. Sheet Metal Material:

a. Aluminum: 0.080 inch (2.03 mm) minimum thickness, with 3003 alloy, and H14 temper.

3. Fabricate curb bottom and mounting flanges for installation directly on metal roof panel system to match slope and configuration of system.

a. Extend side flange to next adjacent roof panel seam and comply with seam configurations and seal connection, providing at least 6 inch (152 mm) clearance between curb and metal roof panel flange allowing water to properly flow past curb.

b. Where side of curb aligns with metal roof panel flange, attach fasteners on upper slope of flange to curb connection allowing water to flow past below fasteners, and seal connection.

c. Maintain at least 12 inch (305 mm) clearance from curb, and lap upper curb flange on underside of down sloping metal roof panel, and seal connection.

d. Lap lower curb flange overtop of down sloping metal roof panel and seal connection.

2.2 SNOW GUARDS

A. Fence Type Snow Guard: Continuous snow guard; manufacturer's standard pipe, bar, channel, or solid rod, set in brackets or posts, with optional plates and metal trim to match roof.

1. Products:

a. Alpine SnowGuards; ASG4025-AL Standing Seam Two-Pipe Snow Guard: www.alpinesnowguards.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.4 CLEANING

A. Clean installed work to like-new condition.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 07 72 00

SECTION 07 84 00 - FIRESTOPPING

PART 2 PRODUCTS

1.1 MATERIALS

A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

1.2 FIRESTOPPING SYSTEMS

END OF SECTION 07 84 00

SECTION 07 92 00 - JOINT SEALANTS

PART 2 PRODUCTS

1.1 JOINT SEALANTS - GENERAL

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Non-fire-rated hollow metal doors and frames.

B. Hollow metal frames for wood doors.

C. Fire-rated hollow metal doors and frames.

D. Thermally insulated hollow metal doors with frames.

E. ~~Sound-rated hollow metal doors and frames.~~Sound-rated hollow metal doors and frames.

F. Hollow metal borrowed lites glazing frames.

1.2 RELATED REQUIREMENTS

A. Section 08 71 00 - Door Hardware.

B. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.

C. Section 09 91 13 - Exterior Painting: Field painting.

D. Section 09 91 23 - Interior Painting: Field painting.

1.3 ABBREVIATIONS AND ACRONYMS

A. ANSI: American National Standards Institute.

B. HMMA: Hollow Metal Manufacturers Association.

C. NAAMM: National Association of Architectural Metal Manufacturers.

D. NFPA: National Fire Protection Association.

E. SDI: Steel Door Institute.

F. UL: Underwriters Laboratories.

1.4 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames; 2025.

C. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2026.

D. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2024.

E. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.

F. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2025.

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

H. ITS (DIR) - Directory of Listed Products; Current Edition.

I. NAAMM HMMA 840 - Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2024.

J. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.

K. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025, with Amendment (2024).

L. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

M. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.

N. UL (DIR) - Online Certifications Directory; Current Edition.

O. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.

C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

D. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

E. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

F. Manufacturer's Qualification Statement.

G. Installer's Qualification Statement.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.

B. Maintain at project site copies of reference standards relating to installation of products specified.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Hollow Metal Doors and Frames:

1. Ceco Door, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
2. Curries, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
3. Mesker, dormakaba Group; FDJ Series Drywall Frames: www.meskeropeningsgroup.com/#sle.
4. Republic Doors, an Allegion brand; ____: www.republicdoor.com/#sle.
5. Steelcraft, an Allegion brand; ____: www.allegion.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS

A. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.3 HOLLOW METAL DOORS

A. Door Finish: Factory primed and field finished.

B. Type ___ , Exterior Doors: Thermally insulated.

1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).

a. Level 1 - Standard-duty.

b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.

c. Model 1 - Full Flush.

d. Door Face Metal Thickness: 20 gauge, 0.032 inch (0.8 mm), minimum.

2. Door Core Material: ~~Manufacturers standard core material/construction and in compliance with requirements~~Polystyrene, 1 lbs/cu ft minimum density.

a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.

3. Door Thermal Resistance: ~~R-Value of 6.0 minimum, for installed thickness of polystyrene~~R-Value of 6.0 minimum, for installed thickness of polystyrene.
4. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
5. Door Face Sheets: Flush.
6. Weatherstripping: Refer to Section 08 71 00.
7. Door Finish: Factory primed and field finished.

C. Type ___ , Interior Doors, Non-Fire-Rated:

1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
    a. Level 1 - Standard-duty.
    b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
    c. Model 1 - Full Flush.
    d. Door Face Metal Thickness: 20 gauge, 0.032 inch (0.8 mm), minimum.
2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
3. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
4. Door Face Sheets: Flush.

D. Type ___ , Fire-Rated Doors:

1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
    a. Level 1 - Standard-duty.
    b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
    c. Model 1 - Full Flush.
    d. Door Face Metal Thickness: 20 gauge, 0.032 inch (0.8 mm), minimum.
2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
3. Provide units listed and labeled by UL (DIR) or ITS (DIR).
    a. Attach fire rating label to each fire rated unit.
4. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
5. Door Face Sheets: Flush.

2.4 HOLLOW METAL FRAMES

A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

B. Exterior Door Frames: ~~Knock-down type~~Full profile/continuously welded type.

1. Frame Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.

2. Frame Finish: Factory primed and field finished.
3. Weatherstripping: Separate, see Section 08 71 00.

C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.

1. Frame Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.
2. Frame Finish: Factory primed and field finished.

D. Door Frames, Fire-Rated: Knock-down type.

1. Fire Rating: Same as door, labeled.
2. Frame Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.
3. Frame Finish: Factory primed and field finished.

E. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.

F. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.

G. Frames Wider than 48 inches (1219 mm): Reinforce with steel channel fitted tightly into frame head, flush with top.

2.5 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.6 ACCESSORIES

A. Glazing: As specified in Section 08 80 00, factory installed.

B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.

C. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Verify that finished walls are in plane to ensure proper door alignment.

3.2 INSTALLATION

A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.

B. Install fire rated units in accordance with NFPA 80.

C. Coordinate frame anchor placement with wall construction.

D. Install door hardware as specified in Section 08 71 00.

E. Comply with glazing installation requirements of Section 08 80 00.

F. Coordinate installation of electrical connections to electrical hardware items.

G. Touch up damaged factory finishes.

3.3 TOLERANCES

A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.

B. Maximum Diagonal Distortion: 1/16 inch (1.6 mm) measured with straight edge, corner to corner.

3.4 ADJUSTING

A. Adjust for smooth and balanced door movement.

END OF SECTION 08 11 13

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Flush wood doors; flush and flush glazed configuration; fire-rated, non-rated, acoustical, special function, and _____.

1.2 RELATED REQUIREMENTS

A. Section 08 11 13 - Hollow Metal Doors and Frames.

B. Section 08 71 00 - Door Hardware.

C. Section 08 80 00 - Glazing .

1.3 REFERENCE STANDARDS

A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.

B. ANSI A208.1 - American National Standard for Particleboard; 2022.

C. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.

D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

F. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

G. AWI (QCP) - Quality Certification Program; Current Edition.

H. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

I. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

J. BHMA A156.13 - Mortise Locks and Latches; 2022.

K. FM (AG) - FM Approval Guide; Current Edition.

L. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. NAAMM HMMA 805 - Recommended Selection and Usage Guide for Hollow Metal Doors and Frames; 2012.

N. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025, with Amendment (2024).

O. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

P. WDMA I.S. 1A - Interior Architectural Wood Flush Doors; 2021, with Errata (2022).

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.

C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.

D. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

E. Test Reports: Show compliance with specified requirements for the following:

1. Sound-retardant doors and frames; sealed panel tests are not acceptable.

F. Manufacturer's Installation Instructions: Indicate special installation instructions.

G. Manufacturer's qualification statement.

H. Specimen warranty.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Package, deliver and store doors in accordance with specified quality standard.

B. Accept doors on site in manufacturer's packaging, and inspect for damage.

C. Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges with tinted sealer if stored more than one week, and break seal on site to permit ventilation.

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wood Veneer Faced Doors:

1. Forte Opening Solutions; Aspiro Select Wood Veneer Doors: www.forteopenings.com/#sle.
2. VT Industries, Inc; ____: www.vtindustries.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 DOORS AND PANELS

A. Doors: See drawings for locations and additional requirements.

1. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.

B. Interior Doors: 1-3/4 inches (44 mm) thick unless otherwise indicated; flush construction.

1. Provide solid core doors at each location.
2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.

2.3 DOOR AND PANEL CORES

A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.

B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.4 DOOR FACINGS

A. Veneer Facing for Transparent Finish: Red oak, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.

1. Vertical Edges: Any option allowed by quality standard for grade.
2. "Running Match" each pair of doors and doors in close proximity to each other.

2.5 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.

B. Cores Constructed with stiles and rails:

1. Provide solid blocks at lock edge for hardware reinforcement.

C. Where supplementary protective edge trim is required, install trim after veneer facing has been applied full-width.

D. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.

E. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

F. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.

G. Provide edge clearances in accordance with the quality standard specified.

2.6 FINISHES - WOOD VENEER DOORS

A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:

1. Transparent:

a. System - 1, Lacquer, Nitrocellulose.

b. Sheen: Flat.

2.7 ACCESSORIES

A. Hollow Metal Door Frames: See Section 08 11 13.

B. Glazing: See Section 08 80 00.

C. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.

D. Door Hardware: See Section 08 71 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.2 INSTALLATION

A. Install doors in accordance with manufacturer's instructions and specified quality standard.

1. Install fire-rated doors in accordance with NFPA 80 requirements.

B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.

C. Use machine tools to cut or drill for hardware.

D. Coordinate installation of doors with installation of frames and hardware.

E. Coordinate installation of glazing.

3.3 TOLERANCES

A. Comply with specified quality standard for fit and clearance tolerances.

B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.4 ADJUSTING

A. Adjust doors for smooth and balanced door movement.

B. Adjust closers for full closure.

END OF SECTION 08 14 16

SECTION 08 31 00 - ACCESS DOORS AND PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

1.2 RELATED REQUIREMENTS

A. Section 08 71 00 - Door Hardware: Mortise cylinder and core hardware.

B. Section 09 91 23 - Interior Painting: Field paint finish.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

C. Manufacturer's Installation Instructions: Indicate installation requirements.

D. Manufacturer's qualification statement.

E. Project Record Documents: Record actual locations of each access unit.

PART 2 PRODUCTS

2.1 ACCESS DOORS AND PANELS ASSEMBLIES

END OF SECTION 08 31 00

SECTION 08 43 13 - ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

B. Infill panels of metal and glass.

C. Aluminum doors and frames.

D. Weatherstripping.

E. Door hardware.

1.2 RELATED REQUIREMENTS

A. Section 07 25 00 - Weather Barriers: Sealing framing to water-resistive barrier installed on adjacent construction.

B. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.

C. Section 08 42 29 - Automatic Entrances.

D. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.

E. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.3 REFERENCE STANDARDS

A. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2025.

B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.

C. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.

D. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2026.

B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

D. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.

E. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.

D. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

E. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.

F. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

G. Manufacturer's qualification statement.

H. Installer's qualification statement.

I. Specimen warranty.

1.6 QUALITY ASSURANCE

1.7 MOCK-UPS

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Construct ~~[____]~~exterior wall assembly mock-up, ~~___ feet (___ m) long by ___ feet (___ m) wide~~, indicating ~~[____]~~coordination of wall assembly components at exterior eindow opening.

C. Locate where directed.

D. Mock-up may remain as part of work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.9 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Aluminum-Framed Storefronts:

1. Kawneer North America; _____: www.kawneer.com/#sle.
2. Oldcastle BuildingEnvelope; _____: www.oldcastlebe.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Entrance Doors:

1. ~~[_____]~~To be same manufacturer as Aluminum-Framed Storefront.

2.2 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING

A. Front-Set Style, Thermally-Broken:

2.3 BASIS OF DESIGN -- SWINGING DOORS

A. Narrow Stile, Insulating Glazing, Thermally-Broken:

1. Basis of Design: _____.
2. Thickness: 1-3/4 inches (43 mm).

2.4 ALUMINUM-FRAMED STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.

~~Glazing Position: Centered (front to back).~~

1. Finish: Superior performing organic coatings.

a. Factory finish all surfaces that will be exposed in completed assemblies.

b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

2. Finish Color: Black.

3. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
4. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
6. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F (95 degrees C) over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Performance Requirements

1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.

   a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.

2. Air Leakage: 0.06 cfm/sq ft (0.3 L/sec sq m) maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf (75 Pa) pressure difference.

2.5 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.

1. Glazing Stops: Flush.

2.6 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Fasteners: Stainless steel.

C. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.7 FINISHES

A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick.

B. Color: As indicated on drawings.

C. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.8 HARDWARE

A. For each door, include weatherstripping, sill sweep strip, and threshold.

B. Other Door Hardware: Storefront manufacturer's standard type to suit application.

1. Finish on Hand-Contacted Items: Polished chrome.
2. For each door, include butt hinges, pivots, push handle, pull handle, exit device, narrow stile handle latch, and closer.

C. Automatic Door Operators and Actuators: See Section 08 42 29.

END OF SECTION 08 43 13

SECTION 08 71 00 - DOOR HARDWARE

PART 2 PRODUCTS

1.1 DESIGN AND PERFORMANCE CRITERIA

A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.

B. Provide individual items of single type, of same model, and by same manufacturer.

C. Provide door hardware products that comply with the following requirements:

1. Applicable provisions of federal, state, and local codes.

1.2 FINISHES

END OF SECTION 08 71 00

SECTION 08 71 13 - POWER DOOR OPERATORS

PART 2 PRODUCTS

1.1 POWER DOOR OPERATORS - GENERAL

A. Electrically Operated or Controlled Hardware: Provide necessary power supplies, relays, and interfaces as required for proper operation; provide wiring between control components and to building power connection in compliance with NFPA 70.

B. Comply with ADA Standards for egress requirements.

C. Comply with NFPA 101 and requirements of authorities having jurisdiction; provide units selected for actual door weight and for light pedestrian traffic unless otherwise indicated.

END OF SECTION 08 71 13

SECTION 08 80 00 - GLAZING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Insulating glass units.

B. Glazing units.

C. Plastic films.

1.2 RELATED REQUIREMENTS

A. Section 07 25 00 - Weather Barriers.

B. Section 07 27 00 - Air Barriers.

C. Section 07 92 00 - Joint Sealants: Sealants for other than glazing purposes.

D. Section 08 11 13 - Hollow Metal Doors and Frames: Glazed lites in doors and borrowed lites.

E. Section 08 14 16 - Flush Wood Doors: Glazed lites in doors.

F. Section 08 43 13 - Aluminum-Framed Storefronts: Glazing provided as part of storefront assembly.

G. Section 10 28 00 - Toilet, Bath, and Laundry Accessories: Mirrors.

1.3 REFERENCE STANDARDS

A. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.

B. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Plastic Films Manufacturers:

1. [ ]Solyx Films; www.solyxfilms.com.

a. GF-1 Basis of Design: SX-3140 Dusted Crystal

b. GF-2 Basis of Design: Custom Design

1) Assume design time to work with manufacturer to realize custom deisgn for lobby.

2.2 GLASS MATERIALS

2.3 INSULATING GLASS UNITS

A. Manufacturers:

1. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulating Glass Units: Types as indicated.

1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
3. Spacer Color: Black.
4. Edge Seal:

    a. Color: Black.

5. Purge interpane space with dry air, hermetically sealed.

END OF SECTION 08 80 00

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Acoustic insulation.

B. Cementitious backing board.

C. Gypsum wallboard.

D. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

A. Section 09 22 16 - Non-Structural Metal Framing.

1.3 REFERENCE STANDARDS

A. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).

B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.

C. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2025.

D. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.

E. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.

F. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2024.

G. GA-216 - Application and Finishing of Gypsum Panel Products; 2024.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data:

1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.

C. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.

2.2 METAL FRAMING MATERIALS

A. Nonstructural Steel Framing for Application of Gypsum Board: See Section 09 22 16.

2.3 BOARD MATERIALS

A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.

1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
3. Thickness:

a. Vertical Surfaces: 1/2 inch (13 mm).

b. Ceilings: 1/2 inch (13 mm).

4. Paper-Faced Products:

a. American Gypsum Company; FireBloc Type X Gypsum Wallboard: www.americangypsum.com/#sle.

b. CertainTeed Corporation; Type X Drywall: www.certainteed.com/#sle.

c. Georgia-Pacific Gypsum; ToughRock Fireguard X: www.gpgypsum.com/#sle.

d. USG Corporation; Sheetrock Brand Firecode X Panels 5/8 in. (15.9 mm): www.usg.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

B. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.

1. Application: Vertical surfaces behind thinset tile, except in wet areas.
2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
3. Type: Regular and Type X, in locations indicated.
4. Type X Thickness: 5/8 inch (16 mm).
5. Regular Board Thickness: 1/2 inch (13 mm).
6. Edges: Tapered.

2.4 GYPSUM BOARD ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness ~~2 inches (50.8 mm)~~3 inches (76.2 mm).

B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

C. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.

1. Corner Beads: Low profile, for 90 degree outside corners.
2. L-Trim with Tear-Away Strip: Sized to fit 1/2-inch (13 mm) thick gypsum wallboard.
3. Architectural Reveal Beads:

a. Shapes: As indicated on drawings.

b. Products:

1) Trim-Tex, Inc; _____: www.trim-tex.com/#sle.

D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.

1. Joint Compound: Setting type, field-mixed.

E. Finishing Compound: Surface coat and primer, takes the place of skim coating.

F. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.2 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.3 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

C. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.

D. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.

3.4 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated on drawings.

1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
2. At exterior soffits, not more than 30 feet (10 meters) apart in both directions.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

D. Decorative Trim: Install at locations shown on drawings and in accordance with manufacturer's instructions.

3.5 JOINT TREATMENT

A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:

1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
3. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
4. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.

1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).

D. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

E. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

END OF SECTION 09 21 16

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal partition, ceiling, and soffit framing.

B. Framing accessories.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping: Sealing top-of-wall assemblies at fire-resistance-rated walls.

1.3 REFERENCE STANDARDS

A. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.

B. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

E. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

F. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.

G. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

H. ASTM C1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections; 2024.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.

C. Manufacturer's qualification statement.

1.5 QUALITY ASSURANCE

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Metal Framing, Connectors, and Accessories:

1. ClarkDietrich; _____: www.clarkdietrich.com/#sle.

2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FRAMING MATERIALS

A. Fire-Resistance-Rated Assemblies: Comply with applicable code and as follows:

B. Firestopping: Materials meeting requirements necessary to maintain rating of penetrated assembly.

1. See Section 07 84 00.
2. Fire Ratings: See drawings for required systems and ratings.

C. Material and Product Requirements: AISI S201 and AISI S220.

D. Nonstructural Framing System Components: Sheet steel, of size and properties necessary for spacing indicated on drawings, with maximum wall framing deflection of L/120 at 10 psf (480 Pa).

1. Studs: C-shaped with flat faces.

a. Products:

1) ClarkDietrich; ProSTUD: www.clarkdietrich.com/#sle.

2) Substitutions: See Section 01 60 00 - Product Requirements.

2. Runners: U-shaped, sized to match studs.
3. Furring: Hat-shaped sections, minimum depth of 7/8 inch (22 mm).
4. Furring: Z-shaped sections, minimum depth of 1 inch (25 mm).
5. Resilient Furring Channels: Single or double leg configuration; 1/2 inch (12 mm) channel depth.

E. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.

F. Preformed Top Track Firestop Seal:

1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.

G. Nonstructural Framing Accessories:

1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.

a. Materials: ASTM A1011/A1011M sheet steel support member with factory-welded ASTM A36/A36M steel plate base.

1) Height: ~~23-5/8 inches (600.1 mm)~~As indicated on the drawings..

2) Products:

(a) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.

3. Bracing and Bridging: ASTM A653/A653M, G90 (Z275) galvanized steel; for lateral bracing of wall studs with slots for engaging on-module studs.

4. Fasteners: ASTM C1513 self-piercing, self-tapping screws.
5. Anchorage Devices: Powder actuated.
6. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness ~~[___] inch ([___] mm)~~3 inch (76.2 mm).
7. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

2.3 FABRICATION

A. Fabricate assemblies of framed sections to sizes and profiles required.

B. Fit, reinforce, and brace framing members to suit design requirements.

PART 3 EXECUTION

3.1 INSTALLATION OF STUD FRAMING

A. Install non-structural members in accordance with ASTM C754.

B. Extend partition framing ~~to structure where indicated and to ceiling in other locations~~as shown in the drawings.

C. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

D. Align and secure top and bottom runners at 24 inches (600 mm) on center.

E. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.

F. Install studs vertically at spacing indicated on drawings.

G. Align stud web openings horizontally.

H. Secure studs to tracks using crimping method. Do not weld.

I. Stud splicing is not permissible.

J. Fabricate corners using a minimum of three studs.

K. Install double studs at wall openings, door and window jambs, not more than 2 inches (50 mm) from each side of openings.

L. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.

M. Blocking: Use wood blocking secured to studs. Provide blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, and opening frames.

N. Furring: Install at spacing and locations shown on drawings. Lap splices a minimum of 6 inches (150 mm).

3.2 CEILING AND SOFFIT FRAMING

A. Comply with requirements of ASTM C754.

B. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.

C. Install furring independent of walls, columns, and above-ceiling work.

D. Securely anchor hangers to structural members or embed them in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.

E. Space main carrying channels at maximum 72 inches (1 800 mm) on center, and not more than 6 inches (150 mm) from wall surfaces. Lap splice securely.

F. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.

G. Place furring channels perpendicular to carrying channels, not more than 2 inches (50 mm) from perimeter walls, and rigidly secure. Lap splices securely.

3.3 TOLERANCES

A. Maximum Variation From True Position: 1/8 inch in 10 feet (3 mm in 3 m).

B. Maximum Variation From Plumb: 1/8 inch in 10 feet (3 mm in 3 m).

END OF SECTION 09 22 16

SECTION 09 30 00 - TILING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Tile for floor applications.

B. Non-ceramic trim.

1.2 REFERENCE STANDARDS

A. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2024.

B. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 2021.

C. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar; 2023.

D. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2014 (Reaffirmed 2024).

E. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.

F. ANSI A326.3 - American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials; 2021.

G. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products; 2018 (Reapproved 2023).

H. TCNA (HB-GP) - Handbook for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs Installation; 2025-2026.

I. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2026.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

C. Installer's qualification statement.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

B. Installer Qualifications:

1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.6 FIELD CONDITIONS

A. Maintain ambient and substrate temperature above 50 degrees F (10 degrees C) and below 100 degrees F (38 degrees C) during installation and curing of setting materials.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Tile:

1. Dal-Tile Corporation: www.daltile.com/#sle.

B. Setting Materials:

C. Grout:

2.2 PERFORMANCE REQUIREMENTS

A. Floor Tile: Provide tile for flooring applications with minimum wet Dynamic Coefficient of Friction (DCOF) of 0.42 when tested in accordance with ANSI A326.3.

2.3 TILE

A. Porcelain Tile, Type _____: ANSI A137.1 standard grade.

1. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
2. Size: ~~6 by 6 inch (152 by 152 mm)~~12 by 24 inch (___by___ mm), nominal.
3. Thickness: ~~3/8 inch (9.5 mm)~~5/16 inch (8 mm).
4. Edges: Interlocking shape.
5. Surface Finish: ~~Unglazed~~Glazed Porcelain with StepWise Technology.
6. Color: ~~As indicated on drawings~~As indicated in Finish Table.

2.4 TRIM AND ACCESSORIES

A. Non-Ceramic Trim: Satin brass anodized extruded aluminum, style and dimensions to suit application, set with tile mortar or adhesive.

1. Applications:

a. Open edges of wall and floor tile.

b. Inside and outside wall corners.

c. Thresholds at door openings.

d. Floor-to-wall joints.

2. Products:

a. Schluter-Systems; Schiene: www.schluter.com/#sle.

2.5 SETTING MATERIALS

A. Provide setting and grout materials from same manufacturer.

B. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.

2.6 GROUTS

A. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.

1. Applications: ~~Use where indicated on drawings~~Floor tile and tile base.
2. Color: As selected by Architect from manufacturer's full line.
3. Products:

a. Mapei Corporation; Kerapoxy CQ: www.mapei.com/#sle.

2.7 ACCESSORY MATERIALS

A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.

1. Crack Resistance: No failure at 1/8 inch (3.2 mm) gap, minimum.
2. Bonded Sheet Membrane Type:

a. Material: Polyethylene sheet membrane with polyester fleece laminated to underside, 20 mils (0.5 mm) thick.

b. Products:

1) Schluter-Systems; DITRA: www.schluter.com/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive tile.

B. Verify wall surfaces are smooth and flat within tolerances specified for that type of work, are dust-free, and are ready to receive tile.

C. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.

3.2 PREPARATION

A. Vacuum clean surfaces and damp clean.

B. Seal substrate surface cracks with filler.

3.3 INSTALLATION - GENERAL

A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108/A118/A136, manufacturer's instructions, and TCNA (HB) or TCNA (HB-GP) recommendations, as applicable.

B. Lay tile to pattern indicated on drawings. Do not interrupt tile pattern through openings.

C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.

D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.

E. Form internal angles square and external angles bullnosed.

F. Install non-ceramic trim in accordance with manufacturer's instructions.

G. Sound tile after setting. Replace hollow sounding units.

H. Keep control and expansion joints free of mortar, grout, and adhesive.

I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.

J. Grout tile joints unless otherwise indicated on drawings. Use standard grout unless otherwise indicated on drawings.

K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.4 INSTALLATION - FLOORS - THIN-SET METHODS

A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, on ground, with standard grout, unless otherwise indicated on drawings.

1. Use uncoupling membrane under tile unless other underlayment is indicated on drawings.

3.5 ~~INSTALLATION - FLOORS - FLOATING~~

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

B. ~~Grout with standard grout.~~

3.6 CLEANING

A. Clean tile and grout surfaces.

3.7 PROTECTION

A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION 09 30 00

SECTION 09 51 00 - ACOUSTICAL CEILINGS - ARMSTRONG

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Acoustical units.

B. Suspension systems.

1.2 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Indicate grid layout and related dimensioning.

C. Product Data: Provide data on suspension system components and acoustical units.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.4 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent before, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.

2.2 ACOUSTICAL UNITS

A. Acoustical ~~Panels~~Tiles~~, Type[ ]~~, ACT-1: With the following characteristics:

1. Classification: ASTM E1264, Type A.
    a. Form: A2.2, wet formed.
2. Size: ~~48 by 72 inches (1219 by 1829 mm)~~24 by 24 inches (610 by 610 mm).
3. Thickness: ~~7/8 inch (22 mm)~~1 inch (____ mm).
4. Light Reflectance: ~~[ ]percent~~0.85 percent, in accordance with ASTM E1264.
5. Articulation Class (AC): ~~[ ]~~170, in accordance with ASTM E1264.
6. Ceiling Attenuation Class (CAC): ~~[ ]~~35, in accordance with ASTM E1264.
7. Noise Reduction Coefficient (NRC): ~~0.80~~0.85 when tested in accordance with ASTM C423 for Type E-400 mounting, in accordance with ASTM E795.
8. Panel Edge: Square.
9. Tile Edge: Square.
10. Color: White.
11. Suspension System, Type ____: Exposed grid.
12. Products:

a. Armstrong World Industries, Inc; Ultima High NRC.

2.3 SUSPENSION SYSTEMS

A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold-down clips, stabilizer bars, clips, and splices as required.

1. Materials:

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers does not interfere with other work.

3.2 PREPARATION

A. Install after major above-ceiling work is complete.

B. Coordinate location of hangers with other work.

3.3 INSTALLATION - SUSPENSION SYSTEMS

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions, as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Where ducts or other equipment prevent regular spacing of hangers, reinforce nearest affected hangers and related carrying channels to span extra distance.

D. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

E. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.

F. Do not eccentrically load system or induce rotation of runners.

3.4 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

E. Cutting Acoustical Units:

1. Make field cut edges of same profile as factory edges.

3.5 REPAIR

3.6 CLEANING

A. Clean surfaces.

END OF SECTION 09 51 00

SECTION 09 65 00 - RESILIENT FLOORING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Resilient sheet flooring.

B. Resilient tile flooring.

C. Static control resilient tile flooring.

D. Resilient base.

1.2 REFERENCE STANDARDS

A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2025a.

B. ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing; 2004 (Reapproved 2021).

C. ASTM F1700 - Standard Specification for Solid Vinyl Floor in Modular Format such as Tile(s) or Plank(s); 2025.

D. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021 (Reapproved 2025).

E. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

C. Shop Drawings: Indicate seaming plans and floor patterns.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.

B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.

B. Store all materials off of the floor in an acclimatized, weather-tight space.

C. Maintain temperature in storage area between 55 degrees F (13 degrees C) and 90 degrees F (72 degrees C).

D. Protect roll materials from damage by storing on end.

E. Do not double stack pallets.

1.6 FIELD CONDITIONS

PART 2 PRODUCTS

2.1 SHEET FLOORING

A. Vinyl Sheet Flooring ~~- Type[____]~~ - WSF-1: Color and pattern throughout wear layer thickness, with backing.

1. Manufacturers:

a. Mannington Commercial; _____: www.manningtoncommercial.com#sle.

b. _____.

2. Minimum Requirements: Comply with ASTM F1303, Type II, with Class A fibrous backing.
3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
4. Wear Layer Thickness: 0.050 inch (1.25 mm) minimum.
5. Total Thickness: 0.080 inch (2.0 mm) minimum.
6. Seams: Heat welded.
7. Integral coved base with cap strip.
8. Pattern: _____.
9. Color: As indicated on drawings.

B. Welding Rod: Solid bead in material compatible with flooring, produced by flooring manufacturer for heat welding seams, and in color matching field color.

2.2 TILE FLOORING

A. Vinyl Tile ~~- Type[____]~~ - LVT-1: Printed film type, with transparent or translucent wear layer; acoustic interlayer or backing.

1. Manufacturers:

a. _____.

2. Minimum Requirements: Comply with ASTM F1700, Class III.
3. Wear Layer Thickness: 0.020 inch (0.50 mm).
4. Total Thickness: 0.20 inch (5 mm).
5. Pattern: _____.
6. Color: ~~As indicated on drawings~~As indicated in Finish Table.

B. Vinyl Tile ~~- Type[____]~~ - LVT-2: Printed film type, with transparent or translucent wear layer; acoustic interlayer or backing.

1. Manufacturers:

a. ~~[____]~~Mohawk Group; www.mohawkgroup.com.

2. Pattern: [____]Tinted Timber Collection.
3. Color: As indicated on drawingsAs indicated in Finish Table.
4.

C. Static Control Tile - Type[____] - SDT-1: Homogeneous; color and pattern throughout thickness.

1. Manufacturers:

a. _____.

2.3 RESILIENT BASE

A. Resilient Base - Type[____] - RB-1: ASTM F1861, Type TP, rubber, thermoplastic; style as scheduled.

1. Manufacturers:

a. Tarkett Flooring: www.tarkett.com/#sle.

2. Height: 4 inches (100 mm).
3. Thickness: 0.125 inch (3.2 mm).
4. Finish: Satin.
5. Color: As indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).

1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.2 PREPARATION

3.3 INSTALLATION - GENERAL

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

3.4 INSTALLATION - SHEET FLOORING

A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.

B. Seal seams by heat welding where indicated.

C. Coved Base: Install as detailed on drawings, using coved base filler as backing at floor to wall junction. Extend sheet flooring vertically to height indicated, and cover top edge with metal cap strip.

3.5 INSTALLATION - TILE FLOORING

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

3.6 INSTALLATION - RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.

B. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.7 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's written instructions.

3.8 PROTECTION

A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 09 65 00

SECTION 09 68 13 - TILE CARPETING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Carpet tile, fully adhered.

1.2 RELATED REQUIREMENTS

A. Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

1.3 REFERENCE STANDARDS

A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).

B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2025a.

C. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.

C. Shop Drawings: Indicate ~~layout of joints~~direction of carpet pile.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.

B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.6 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Tile Carpeting:

1. Mohawk Group; ____: www.mohawkgroup.com/#sle.

2.2 MATERIALS

A. Tile Carpeting, Type _____: Tufted, manufactured in one color dye lot.

1. Product: [____]Above & Below Collection manufactured by [____]Mohawk.
2. Tile Size: 18 by 18 inch (450 by 450 mm)12 by 36 inch (____by____ mm), nominal.
3. Pile Thickness: [____] inch ([____] mm)0.115 inch (____ mm).
4. Color: [____]TBD.
5. Pattern: [____]MycoBiome.
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
8. Gauge: [____] inch ([____] mm)1/12 inch (____ mm).
9. Stitches: [____] per inch ([____] per cm)9.33 per inch (____ per cm).
10. Primary Backing Material: PolypropyleneEcoflex One.

2.3 ACCESSORIES

A. Edge Strips: Embossed aluminum, [____]colorcolor as selected by Architect.

B. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

3.2 PREPARATION

A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

3.3 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install carpet tile in accordance with manufacturer's instructions.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.

F. Trim carpet tile neatly at walls and around interruptions.

G. Complete installation of edge strips, concealing exposed edges.

3.4 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

END OF SECTION 09 68 13

SECTION 09 91 13 - EXTERIOR PAINTING

PART 2 PRODUCTS

1.1 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.

1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
2. Supply each paint material in quantity required to complete entire project's work from a single production run.
3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.

PART 3 EXECUTION

2.1 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

2.2 APPLICATION

A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance.

D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

END OF SECTION 09 91 13

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.

D. Do Not Paint or Finish the Following Items:

1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
2. Items indicated to receive other finishes.
3. Items indicated to remain unfinished.
4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
5. Floors, unless specifically indicated.
6. Glass.
7. Concealed pipes, ducts, and conduits.

1.2 REFERENCE STANDARDS

A. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020 (Reapproved 2025).

B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

C. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

D. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning; 2006.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide complete list of products to be used, with the following information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
2. MPI product number (e.g., MPI #47).
3. Cross-reference to specified paint system products to be used in project; include description of each system.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum _____ years experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.6 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Provide lighting level of 80 fc (860 lux) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.

B. Paints:

1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.

C. Primer Sealers: Same manufacturer as top coats.

2.2 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.

1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
2. Supply each paint material in quantity required to complete entire project's work from a single production run.
3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

B. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

C. Colors: To be selected from manufacturer's full range of available colors.

1. Selection to be made by Architect after award of contract.

2.3 PAINT SYSTEMS - INTERIOR

A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, brick, wood, plaster, uncoated steel, shop primed steel, galvanized steel, aluminum, and acoustical ceilings.

1. Two top coats and one coat primer.
2. Top Coat(s): Institutional Low Odor/VOC Interior Latex; MPI #143, 144, 145, 146, 147, or 148.
3. Top Coat Sheen:

a. Flat: MPI gloss level 1; use this sheen for ceilings and other overhead surfaces.

b. Eggshell: MPI gloss level 3; use this sheen ~~at all locations~~for walls.

B. Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:

1. Medium duty applications include doors, door frames, railings, handrails, guardrails, and balustrades.
2. Two top coats and one coat primer.
3. Top Coat Sheen:

a. Semi-Gloss: MPI gloss level 5; use this sheen ~~at all locations~~at door frames.

2.4 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

2.5 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin application of paints and finishes until substrates have been adequately prepared.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

E. Test shop-applied primer for compatibility with subsequent cover materials.

F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:

1. Gypsum Wallboard: 12 percent.
2. Plaster and Stucco: 12 percent.
3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.2 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Concrete:

F. Masonry:

G. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.

H. Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high-alkali surfaces.

I. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.

J. Galvanized Surfaces:

K. Ferrous Metal:

1. Solvent clean according to SSPC-SP 1.
2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning in accordance with SSPC-SP 6/NACE No.3. Protect from corrosion until coated.

L. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

M. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.

3.3 APPLICATION

A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

D. Sand wood and metal surfaces lightly between coats to achieve required finish.

E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.4 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.5 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 91 23

SECTION 10 14 23 - PANEL SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Panel signage.

1.2 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Shop Drawings:

1. Include dimensions, locations, elevations, materials, text and graphic layout, attachment details, and schedules.

C. Manufacturer's qualification statement.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Package signs as required to prevent damage before installation.

1.5 FIELD CONDITIONS

A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.

B. Maintain minimum ambient temperature during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Panel Signage:

1. Takeform: www.takeform.net/#sle.

2.2 PANEL SIGNAGE

A. Panel Signage ~~Type[ ]:~~

1. Application: ~~Room and door~~Clinic entry signage signs.
2. Description: ~~Flat~~Custom printed graphic panel signs. ~~signswith engraved panelmedia, tactile characters.~~
3. Sign Size: ~~4 inches by 6 inches (100 mm by 152 mm)~~As indicated on drawings.
4. Total Thickness: ~~1/8 inch (3 mm)~~1/2 inch ( ) mm).
5. Sign Edges: Squared.
6. Corners: Squared.
7. ~~Color and Font~~Graphics:To be developed with owner input. ~~, unless otherwise indicated:~~

a. ~~Character Font: Helvetica, Arial, or other sans serif font_____.~~

b. ~~Character Case: Upper and lower case (title case).~~

c. ~~Background Color: As scheduled.~~

d. ~~Character Color: Contrasting color.~~

8. ~~Material: Laminated colored plastic engraved through face to expose core as background color.~~
9. Profile: Flat panel in aluminum frame.

a. ~~Frame Finish: Black anodized.~~

10. ~~Tactile Letters: Raised 1/32 inch minimum.~~

2.3 ACCESSORIES

A. ~~Exposed Screws~~Stand-Off Mounting: ~~Chrome plated~~Stainless steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install with horizontal edges level.

C. Protect from damage until mm-dd-yyyy; repair or replace damaged items.

END OF SECTION 10 14 23

SECTION 10 26 00 - WALL AND DOOR PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Corner guards.

B. End Wall Guards.

C. Chair Rails.

1.2 REFERENCE STANDARDS

A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2024.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

C. ASTM F476 - Standard Test Methods for Security of Swinging Door Assemblies; 2023.

PART 2 PRODUCTS

2.1 MANUFACTURERS

2.2 PERFORMANCE CRITERIA

A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for compliance with applicable provisions of ASTM D256 and/or ASTM F476.

2.3 PRODUCT TYPES

A. Corner Guards - Surface Mounted:

1. Thickness: ~~0.075 inch (1.9 mm)~~.080 inch (____ mm) rigid vinyl cover.
2.
3. Thickness: ~~0.075 inch (1.9 mm)~~.070 inch (____ mm) recycled vinyl Retainer.
4.
5. Performance: Resist lateral impact force of 100 lbs (445 N) at any point without damage or permanent set.
6. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
7. Width of Wings: ~~2 inches (51 mm)~~3 inches (76 mm).
8. Corner: Square.
9. Color: As selected from manufacturer's standard colors.
10. Length: One piece, 48 inches (1219 mm).
11. Mounting: Countersunk screws through factory-drilled holes.
12. Preformed end caps.

B. End Wall Guards - Surface Mounted:

1. Thickness: .080" rigid vinyl cover
2. Thickness: .060" rigid vinyl strip
3. Thickness: .070" recycled vinyl retainer
4. Height: 48".
5. Color: As selected from manufacturer's standard colors.

C. Chair Rail - Surface Mounted:

1. Thickness: 1/2"
2. Width: 4"
3. Color: As selected from manufacturer's FULL RANGE.

2.4 FABRICATION

A. Fabricate components with tight joints, corners and seams.

B. Pre-drill holes for attachment.

C. Form end trim closure by capping and finishing smooth.

2.5 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Provide wall and door protection systems of each type from a single source and manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.

B. Verify that field measurements are as indicated on drawings.

C. Verify that substrate surfaces for adhered items are clean and smooth.

1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.

3.2 INSTALLATION

A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.

B. Position corner guard 4 inches (102 mm) above finished floor to ~~[____] inches high ([____] mm high)~~48 inches high (____ mm high).

C. Position end guard 4 inches (102 mm) above finished floor to ~~[____] inches high ([____] mm high)~~48 inches high (____ mm high) .

D. Position chair rail ~~4 inches (102 mm)~~32 inch (_____ mm) above finished floor. ~~[____] inches high ([____] mm high).~~

1. Terminate chair rails 1 inch (25.4 mm)[6] inch ([_____] mm) short of door openings and intersecting walls.

3.3 CLEANING

A. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION 10 26 00

SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Commercial toilet accessories.

B. Diaper changing stations.

C. Utility room accessories.

1.2 REFERENCE STANDARDS

A. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

B. ASTM C1036 - Standard Specification for Flat Glass; 2025.

C. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2024.

D. ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use; 2022.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Commercial Toilet, Shower, and Bath Accessories:

1. Bobrick, Inc; www.bobrick.com ~~American Specialties, Inc; _____: www.americanspecialties.com/#sle~~.

B. Diaper Changing Stations:

1. Koala Kare Products; _____: www.koalabear.com/#sle.

2.2 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.

1. Grind welded joints smooth.
2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.

B. Stainless Steel Sheet: ASTM A666/A666M, Type 304.

C. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

2.3 FINISHES

A. Stainless Steel: Satin finish, unless otherwise noted.

2.4 COMMERCIAL TOILET ACCESSORIES

A. Mirrors: Stainless steel framed, 1/4 inch (6 mm) thick annealed float glass; ASTM C1036.

1. Basis of Design: Bobrick B-290

B. Grab Bars: Stainless steel, smooth surface.

1. Basis of Design: Bobrick B-9806

C. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.

1. Basis of Design: Bobrcik B-35139

D. Robe Hook: Heavy-duty stainless steel, single-prong, rectangular-shaped bracket and backplate for concealed attachment, satin finish.

1. Basis of Design: Bobrick B-9542

E. Specimen Pass Thru

1. Basis of Design: Bobrick B-50516

2.5 DIAPER CHANGING STATIONS

A. Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.

1. Basis of Design: Bobrick KB310-SSRE
2. Material: ~~Polyethylene~~Stainless steel.
3. Mounting: ~~Surface~~Recessed.

2.6 UTILITY ROOM ACCESSORIES

A. Mop and Broom Holder: 0.05 inch (1.3 mm) thick stainless steel, Type 304, hat-shaped channel.

B. Basis of Design: Bobrcik B-239x34

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify exact location of accessories for installation.

C. Verify that field measurements are as indicated on drawings.

D. See Section _____ for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.2 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.

B. Provide templates and rough-in measurements as required.

3.3 INSTALLATION

A. Install plumb and level, securely and rigidly anchored to substrate.

B. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.4 PROTECTION

A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 28 00

SECTION 10 56 17 - WALL MOUNTED STANDARDS AND SHELVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Steel shelf standards, brackets, and accessories.

B. Shelves.

C. See drawings for locations and configurations.

1.2 REFERENCE STANDARDS

A. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products under cover and elevated above grade.

B. Store products in manufacturer's unopened packaging until ready for installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Steel Shelf Standards and Brackets:

1. Knape & Vogt Manufacturing Company; 87™/187™ Series: www.knapeandvogt.com/#sle.

2.2 COMPONENTS

A. Steel Shelf Standards, Brackets, and Accessories:

1. Super-Duty Shelf Standards and Brackets: Single-slotted channel standards for brackets adjustable in 1 inch (25 mm) increments along entire length of standard, drilled and countersunk for screws.

a. Product: KV 87/187.

b. Load Capacity: Recommended by manufacturer for loading of 540 to 1,060 pounds (245 to 480 kg) per pair of standards.

c. Face Width: 5/8 inch (16 mm), single slotted.

d. Material: 12 gauge, 0.1046 inch (2.66 mm) sheet steel.

e. Lengths: As indicated on drawings.

f. Finish: Electroplated, chrome-look.

g. Brackets: 12 gauge, 0.1046 inch (2.66 mm) sheet steel, reinforced, locking into slots with molded nylon cam lock lever; size to suit shelves; same finish as standards.

h. Bracket Quantity: Provide one bracket for each 12 inches (305 mm) of standard length.

B. Shelving:

1. Laminate Faced Shelves: Particleboard or medium density fiberboard covered with high pressure decorative laminate on both sides.

a. Edge Finish: Matching laminate, all four edges.

b. Substrate Thickness: 3/4 inch (19 mm), nominal.

c. Laminate: NEMA LD 3 Type HGL.

d. Laminate Color and Pattern: To be selected by Architect from manufacturer's full line.

C. Fasteners: Screws as recommended by manufacturer for intended application or as otherwise required by project conditions. Finish of exposed to view fasteners to match finish of standards and other components.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount standards or brackets to solid backing capable of supporting intended loads.

C. Install brackets, shelving, and accessories.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 10 56 17

SECTION 10 73 16.13 - METAL CANOPIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Freestanding metal canopies.

B. Attached metal canopies.

1.2 REFERENCE STANDARDS

A. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.

B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

C. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.

D. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2025.

E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

H. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles; 2020.

I. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube; 2020.

J. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs; 2024.

K. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi, 144 ksi, and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2025a.

L. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Submit product data sheets, including material descriptions and finishes, and preparation instructions and recommendations.

C. Shop Drawings: Prior to commencement of fabrication, submit detailed shop drawings, showing profiles, sections of components, finishes, and fastening details.

D. Design Data: Submit comprehensive structural analysis of design for the specified loads. Stamp and sign calculations by professional engineer.

E. Manufacturer's Qualification Statement.

F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site ready for erection.

B. Package using methods that prevent damage during shipping and storage on site.

C. Store materials under cover and elevated above grade.

PART 2 PRODUCTS

2.1 METAL CANOPIES

A. Shop Fabricated Aluminum Canopy ~~Type: [ ].~~

B. Basis of Design Product:

1. Awnex Inc. - Colorado Canopy

C. Configuration: Layout and dimensions, column layout, canopy clearance, fascia profile, and roof covering design as indicated on drawings.

1. Installation: Freestanding.
2. Structural Framing System: Steel.
3. Covering Material: Steel.
4. Drainage Concept: Water collected in decking conducted into internal perimeter ~~drain beams~~gutters and discharged through ~~columns~~downspouts.

D. Performance Requirements:

1. Design and fabricate metal canopy system to resist wind, snow, live, and seismic loads without failure, damage, or permanent deflection in accordance with ASCE 7:
2. Thermal Movement: Design canopy system to accommodate thermal movement caused by ambient temperature range of 120 degrees F (49 degrees C) and surface temperature range of 180 degrees F (82 degrees C) without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects on assembly components.

2.2 COMPONENTS

A. Structural Aluminum Framing: Alloy and temper 6063-T5, 6063-T6, or 6061-T6.

1. Extruded Shapes and Tubes: ASTM B221 (ASTM B221M).
2. Rolled or Extruded Structural Shapes: ASTM B308/B308M.
3. Extruded Structural Pipe and Tube: ASTM B429/B429M.
4. Sheet and Plate: Alloy 5052, 5005, or 6061-T651, ASTM B209/B209M.

B. Covering:

1. Aluminum Decking:

a. Interlocking extruded aluminum decking modules.

1) Extruded Decking: ASTM B221 (ASTM B221M), Alloy and temper 6005-T5, 6061-T6, or 6063-T6.

b. Decking Orientation: Perpendicular to sidewalk.

2. Aluminum Standing Seam Panels: See Section 07 61 00.

C. Fascia: Manufacturer's standard perforated profile.

1. Material: Aluminum Composite Material (ACM) panel.

D. Anchor Bolts: ASTM A307 or ASTM A572/A572M, formed with bent shank, assembled with template for casting into concrete.

1. Minimum exposed thread of 7 inches (178 mm) above footing and 23 inch (584 mm) minimum embedment.
2. Provide nuts and washers as required for column leveling and plumbing.

E. Concrete Footings: Refer to Section 03 30 00 for additional requirements.

F. Exposed Gutters and Downspouts: Galvanized steel with baked enamel finish, color to match canopy covering, manufacturer's recommended size for canopy specified.

2.3 SHOP FABRICATION

A. Provide a complete system ready for erection at project site.

B. Shop fabricate to the greatest extent possible; disassemble if necessary for shipping.

C. Weld steel members in accordance with AWS D1.1/D1.1M.

D. Fabricate connections for bolt, nut, and washer connectors.

2.4 FINISHES

A. Structural Steel Framing:

1. Shop Primer: Rust-inhibitive red oxide.

B. Aluminum Framing and Decking:

1. Pigmented Organic Coatings: AAMA 2603, polyester or acrylic baked enamel finish.
2. Color: ~~As indicated on the drawings~~Selected by Architect from Manufacturer's full range of colors. .

C. Fascia: Fluoropolymer finish; color as selected from manufacturer's standard range.

2.5 ACCESSORIES

A. Structural Bolts: ASTM F3125/F3125M, Grade A325, minimum 3/4 inch (19 mm) diameter.

B. Trim, Closure Pieces, and Flashings: Same material, thickness and finish as sheet metal decking; factory-fabricated to required profiles.

1. Exposed Fasteners: Not permitted.

C. Fasteners, Non-Structural: ASTM F593 stainless steel or ASTM A307 carbon steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and site area for conditions that might prevent satisfactory installation.

B. Verify that foundation, electrical utilities, and placed anchors are in correct position.

C. Verify that bearing surfaces are ready to receive this work.

D. Do not proceed with installation until all conditions are satisfactory.

3.2 INSTALLATION - FRAMING

A. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation.

B. Set column base plates with non-shrink grout to achieve full plate bearing.

C. Fasten columns to anchor bolts.

D. Do not field cut or alter structural members without approval.

E. After erection, prime welds, abrasions, and surfaces not shop primed.

3.3 INSTALLATION - CANOPY COVERING

A. Install in accordance with manufacturer's instructions.

B. Fasten metal decking to metal support members, aligned level and plumb.

C. Install fascia panels, trim, and flashing.

D. Separate dissimilar metals using concealed bituminous paint.

E. Touch-up damaged finish coating using material provided by manufacturer to match original coating.

3.4 TOLERANCES

A. Maximum Variation from Level: Plus/Minus 1/8 inch (3.175 mm).

3.5 CLEANING

A. Clean surfaces of dust and debris; follow manufacturer's cleaning instructions for the finish used.

3.6 PROTECTION

A. Protect canopy after installation to prevent damage due to other work until Date of Substantial Completion.

END OF SECTION 10 73 16.13

SECTION 12 36 00 - COUNTERTOPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Countertops for architectural cabinet work.

1.2 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

B. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.

C. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

D. PS 1 - Structural Plywood; 2023.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.

C. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 COUNTERTOPS

A. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.

1. Flat Sheet Thickness: 1/2 inch (12 mm), minimum.

2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.

   a. Manufacturers:

      1) Dupont; _____: www.corian.com/#sle.

   b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.

   c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.

   d. Color and Pattern: As selected by Architect from manufacturer's full line.

3. Other Components Thickness: 1/2 inch (12 mm), minimum.
4. Back and End Splashes: Same sheet material, square top; minimum 4 inches (102 mm) high.

2.2 MATERIALS

A. Wood-Based Components:

   1. Wood fabricated from old growth timber is not permitted.

B. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch (19 mm) thick; join lengths using metal splines.

C. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

2.3 ACCESSORIES

A. Fixed Top-Mounted Countertop Support Brackets:

   1. Material: Steel.
   2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
   3. Color: Black.
   4. Products:

      a. Centerline Brackets; Front Mounting Countertop Support: www.countertopbracket.com/#sle.

2.4 FABRICATION

A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.

   1. Join lengths of tops using best method recommended by manufacturer.
   2. Fabricate to overhang fronts and ends of cabinets 1 inch (25 mm) except where top butts against cabinet or wall.
   3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.

B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.

1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
2. Height: 4 inches (102 mm), unless otherwise indicated.

C. Solid Surfacing: Fabricate ~~tops and wall panels~~tops up to 144 inches (3657 mm) long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

1. Integral sinks: Shop-mount securely to countertop with adhesives, using flush configuration, as per manufacturer's instructions, and as detailed on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.

B. Seal joint between back/end splashes and vertical surfaces.

3.4 CLEANING

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 12 36 00

SECTION 12 48 13 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Carpet mat.

1.2 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating properties of walk-off surface, component dimensions and recessed frame characteristics.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Floor Mats:

1. Mohawk; Tuff Stuff II Collection; www.mohawkgroup.com

2.2 FLOOR MATS

A. Carpet Mat: Cut nylon pile permanently bonded to vinyl backing; ____ inch (____ mm) wide by ____ inches (____ mm) long with 1-inch (25 mm) black matching vinyl border on all edges.

1. Colors: As indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that floor opening for mats are ready to receive work.

3.2 INSTALLATION

A. Install walk-off surface in floor recess flush with finish floor after cleaning of finish flooring.

END OF SECTION 12 48 13

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Above ground piping.

B. Escutcheons.

C. Expansions - hose and braid.

D. Mechanical couplings.

E. Pipe hangers and supports.

F. Pipe sleeves.

G. Pipe sleeve-seal systems.

H. Piping specialties.

I. Pressure gauges.

J. Pressure relief valves.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 09 91 23 - Interior Painting: Preparation and painting of interior fire protection piping systems.

C. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment: Piping identification.

D. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.3 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings; 2024.

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.

E. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.

F. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2024.

G. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.

H. ASME B16.25 - Buttwelding Ends; 2022.

I. ASME B36.10M - Welded and Seamless Wrought Steel Pipe; 2022.

J. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.

K. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.

L. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

M. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

N. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2021.

O. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.

P. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.

Q. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2021.

R. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.

S. AWWA C606 - Grooved and Shouldered Joints; 2022.

T. FM (AG) - FM Approval Guide; Current Edition.

U. ITS (DIR) - Directory of Listed Products; Current Edition.

V. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

W. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; 2024.

X. NFPA 1963 - Standard for Fire Hose Connections; 2019.

Y. UL (DIR) - Online Certifications Directory; Current Edition.

Z. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.

C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

D. Manufacturer's qualification statement.

1.5 QUALITY ASSURANCE

A. Comply with FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey requirements.

B. Valves: Bear FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.

C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Sprinkler-based System:

1. Comply with NFPA 13.
2. See Section 21 13 00.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

C. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.2 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A795 Schedule 10, ASME B36.10M Schedule 5, ASTM A53 Schedule 40, ASTM A135/A135M Schedule 10, ASTM A135/A135M UL listed light wall type, or ASTM A795 Schedule 40, black.

1. Steel Fittings: ASME B16.9 wrought steel, buttwelded, ASME B16.25 buttweld ends, ASTM A234/A234M wrought carbon steel or alloy steel, ASME B16.5 steel flanges and fittings, or ASME B16.11 forged steel socket welded and threaded.
2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.3 PIPE SLEEVES

A. Vertical Piping:

1. Sleeve Length: 1 inch (25 mm) above finished floor.
2. Provide sealant for watertight joint.

3. Blocked Out Floor Openings: Provide 1-1/2 inch (40 mm) angle set in silicon adhesive around opening.
4. Drilled Penetrations: Provide 1-1/2 inch (40 mm) angle ring or square set in silicone adhesive around penetration.

B. Pipe Passing Through Below Grade Exterior Walls:

1. Zinc-coated or cast-iron pipe.
2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

2.4 PIPE SLEEVE-SEAL SYSTEMS

A. Manufacturers:

1. Advance Products & Systems, Inc; _____: www.apsonline.com/#sle.
2. GPT, a company of Enpro Industries, Inc; _____: www.gptindustries.com/#sle.

B. Modular Mechanical Seals:

1. Elastomer-based interlocking links to continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
3. Size and select seal component materials in accordance with service requirements.
4. Service Requirements:

a. Corrosion resistant.

b. Oil, fuel, gas, and solvent resistant.

c. Underground, buried, and wet conditions.

d. Fire Resistance: 1 hour, UL (DIR) approved.

e. Low temperature, down to minus 67 deg F (minus 55 deg C).

5. Glass-reinforced plastic pressure end plates.

C. Wall Sleeve: PVC material with waterstop collar, and nailer end caps.

D. Sleeve-Forming Disk: Nonconductive plastic-based material, 3 inch (76.2 mm) thick.

E. Pipeline-Casing Seals:

1. Carbon steel band with riser for 12 inch (305 mm) carrier pipe.
2. End Seals: 1/8 inch (3.1 mm), pull-on type, rubber or synthetic rubber based.

2.5 ESCUTCHEONS

A. Material:

1. Fabricate from nonferrous metal.
2. Chrome-plated.
3. Metals and Finish: Comply with ASME A112.18.1.

B. Construction:

1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.6 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm): Malleable iron, adjustable swivel, split ring.

B. Hangers for Pipe Sizes 2 inches (50 mm) and Over: Carbon steel, adjustable, clevis.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

D. Vertical Support: Steel riser clamp.

E. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.7 EXPANSION JOINTS AND LOOPS - HOSE AND BRAID

A. Manufacturers:

1. The Metraflex Company; FireLoop: www.metrafire.com/#sle.
2. Flex-Hose Co. Inc; _____: www.flexhose.com/#sle.
3. Flex-Weld, Inc; _____: www.kelcoind.com/#sle.

B. Provide flexible loops with two flexible sections of hose and braid, two 90-degree elbows, and 180-degree return with support bracket and air release or drain plug.

C. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.

D. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.

1. Maximum Allowable Working Pressure: 150 psig (1030 kPa) at 120 degrees F (49 degrees C).
2. Accommodate the Following:
    a. Axial Deflection in Compression and Expansion: _____ inch (_____ mm).
    b. Lateral Movement: _____ inch (_____ mm).
    c. Angular Rotation: 15 degrees.
    d. Force developed by 1.5 times specified maximum allowable operating pressure.
3. End Connections: Same as specified for pipe jointing.
4. Provide necessary accessories including, but not limited to, swivel joints.

2.8 MECHANICAL COUPLINGS

A. Rigid Mechanical Couplings for Grooved Joints:

1. Dimensions and Testing: Comply with AWWA C606.

2. Minimum Working Pressure: 300 psig (2065 kPa).
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

2.9 PRESSURE GAUGES

A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Steel with brass bourdon tube.
2. Diameter: 4-1/2 inch (115 mm).
3. Mid-Scale Accuracy: One percent.
4. Scale: Display in psi and kPa.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Pipe Hangers and Supports:

1. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
2. Place hangers within 12 inches (300 mm) of each horizontal elbow.
3. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

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

    a. Painting of interior fire suppression systems is specified in Section 09 91 23.

G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

H. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.

1. Painting of interior fire suppression systems is specified in Section 09 91 23.

I. Structural Considerations:

1. Do not penetrate building structural members unless indicated.

J. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
2. All Rated Openings: Caulk tight with firestopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.
3. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

K. Manufactured Sleeve-Seal Systems:

1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a watertight seal.
6. Install in accordance with manufacturer's recommendations.

L. Escutcheons:

1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

N. Die-cut threaded joints with full-cut, standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

3.3 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION 21 05 00

SECTION 21 05 53 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe markers.

E. Ceiling tacks.

1.2 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting: Stencil paint.

1.3 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Automatic Controls: Tags.

B. Control Panels: Nameplates.

C. Instrumentation: Tags.

D. Major Control Components: Nameplates.

E. Piping: Tags.

F. Pumps: Nameplates.

G. Valves: Nameplates and ceiling tacks where above lay-in ceilings.

2.2 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved letters.

1. Letter Color: White.
2. Letter Height: 1/4 inch (6 mm).
3. Background Color: Black.
4. Thickness: 1/8 inch (3 mm).

2.3 TAGS

A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 STENCILS

A. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch (20-30 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 1/2 inch (15 mm) high letters.
2. 1-1/2 to 2 inch (40-50 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 3/4 inch (20 mm) high letters.
3. 2-1/2 to 6 inch (65-150 mm) Outside Diameter of Insulation or Pipe: 12 inch (300 mm) long color field, 1-1/4 inch (30 mm) high letters.
4. Equipment: 2-1/2 inch (65 mm) high letters.

B. Paint for Stencils: As specified in Section 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.

2.5 PIPE MARKERS

A. Color: Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

D. Color code as follows:

1. Fire Quenching Fluids: Red with white letters.

2.6 CEILING TACKS

A. Description: ~~Steel with~~ 3/4 inch (20 mm) ~~self-adhesive vinyl~~diameter self-adhesive vinylcolor coded stickers.~~head.~~

1. Apply stickers to ceiling T-bars. Do not install in areas of gypsum or wood ceilings.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

3.2 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09 91 23.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

F. Use tags on piping 3/4 inch (20 mm) diameter and smaller.

G. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 21 05 53

SECTION 21 13 00 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. System design, installation, and certification.

C. Fire department connections.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 21 05 00 - Common Work Results for Fire Suppression: Pipe and fittings.

C. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment.

D. Section 21 30 00 - Fire Pumps.

E. Section 28 46 00 - Fire Detection and Alarm.

1.3 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide; Current Edition.

B. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NFPA 1963 - Standard for Fire Hose Connections; 2019.

D. UL 405 - Standard for Safety Fire Department Connection Devices; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Shop Drawings:

1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
3. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.

D. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements for additional provisions.
2. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
3. Sprinkler Wrenches: For each sprinkler type.

F. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.5 QUALITY ASSURANCE

A. Comply with FM (AG) requirements.

B. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

C. Equipment and Components: Provide products that bear FM (AG) label or marking.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Sprinklers, Valves, and Equipment:

1. Anvil International; _____: www.anvilintl.com/#sle.
2. Tyco Fire Protection Products; _____: www.tyco-fire.com/#sle.
3. Viking Corporation; _____: www.vikinggroupinc.com/#sle.

2.2 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for entire building.

B. Occupancy: Light hazard; comply with NFPA 13.

C. Water Supply: Determine volume and pressure from water flow test data.

D. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.3 SPRINKLERS

A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.

1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Escutcheon Plate Finish: Antique Brass.
5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

B. Exposed Occupied Area Type: ~~Pendant~~Upright type with guard.

1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

C. Exposed Unoccupied Area Type: Upright type with heavy duty guard.

1. Response Type: Quick.
2. Coverage Type: Extended.
3. Finish: Rough Brass.
4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

D. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.

1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Escutcheon Plate Finish: Brass.
5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

E. Dry Sprinklers: Concealed pendant type with matching push on escutcheon plate. Size barrel for -20 deg F ambient conditions and account for any insulation thickness.

1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Cover Plate Finish: Brass.
5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

F. Guards: Finish to match sprinkler finish.

2.4 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:

1. Activate electric alarm.
2. Test and drain valve.
3. Replaceable internal components without removing valve from installed position.

B. Backflow Preventer: Reduced pressure principle valve assembly backflow preventer with drain and OS & Y gate valve on each end.

C. Test Connections:

1. Inspector's Test Connection for Preaction Systems:

a. Provide test connections approximately 6 ft (2 m) above floor for each or portion of each sprinkler system equipped with an alarm device, located at the most remote part of each system.

b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.

c. Supply discharge orifice with same size as corresponding sprinkler orifice.

d. Limit vertical height of exterior wall penetration to 2 ft (0.61 m) above finished grade.

2. Backflow Preventer Test Connection:

a. Provide downstream of the backflow prevention assembly, listed hose valves with 2.5 inch (65 mm) National Standard male hose threads with cap and chain.

b. Provide permanent sign reading "Test Valve" in accordance with Section 21 05 53.

D. Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.

E. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

F. Fire Department Connections:

1. Type: Free standing made of corrosion resistant metal complying with UL 405.

a. Inlets: Two way, 2-1/2 inch (65 DN) swivel fittings, internal threaded. Thread size and inlets to be coordinated with local fire department, according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.

b. Configuration: Horizontal.

c. Outlet: Bottom with pipe threads, 4 NPS (100 DN).

d. Rated Working Pressure: 175 psi (1200 kPa).

e. Finish: Chrome.

f. Sleeve: Brass, 18 inches (460 mm) height.

g. Signage: Raised or engraved lettering 1 inch (25.4 mm) minimum indicating system type.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

C. Provide approved double check valve assembly at sprinkler system water source connection.

D. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

E. Locate outside alarm gong on building wall as indicated.

F. Place pipe runs to minimize obstruction to other work.

G. Place piping in concealed spaces above finished ceilings.

H. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

I. Install and connect to fire pump system in accordance with Section 21 30 00.

J. Flush entire piping system of foreign matter.

K. Install guards on sprinklers where indicated.

L. Hydrostatically test entire system.

M. Require test be witnessed by Fire Marshal.

3.2 SCHEDULES

A. System Hazard Areas:

1. Offices and Exam Rooms: Light Hazard.
2. ~~Warehouse~~Mechanical and Electrical Utility Spaces: Ordinary Hazard, Group ~~2~~1.
3. Co~~mputer~~nference Room: Light Hazard~~, Preaction~~.

END OF SECTION 21 13 00

SECTION 21 30 00 - FIRE PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Inline fire pump.

B. Electric motor drive.

C. Jockey pump.

1.2 RELATED REQUIREMENTS

A. Section 21 05 00 - Common Work Results for Fire Suppression: Fire protection piping.

B. Section 21 05 13 - Common Motor Requirements for Fire Suppression Equipment.

C. Section 21 05 48 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.

D. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

E. Section 28 46 00 - Fire Detection and Alarm.

1.3 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide; Current Edition.

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection; 2025.

E. UL 448 - Centrifugal Stationary Pumps for Fire-Protection Service; Current Edition, Including All Revisions.

F. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.

C. Shop Drawings: Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly.

D. Certificates: Certify that fire pumps meet or exceed specified requirements at specified operating conditions and that the installation complies with regulatory requirements. Submit summary and results of shop tests performed in accordance with NFPA 20

E. Operation Data: Include manufacturers instructions, start-up data, trouble-shooting check lists, for pumps, drivers, and controllers.

F. Maintenance Data: Include manufacturers literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 13 and NFPA 20; where requirements differ comply with the most stringent.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire pumps and components in factory packing. Comply with manufacturer's rigging and installation instructions.

B. Protect fire pumps and components from physical damage including effects of weather, water, and construction debris.

C. Provide temporary inlet and outlet caps, and maintain in place until installation.

PART 2 PRODUCTS

2.1 FIRE PUMPS

A. Inline Fire Pump:

1. Manufacturers:

a. AC Fire Pump, a Xylem brand; _____: www.acfirepump.com/#sle.

b. Pentair Aurora; Series 911: www.pentair.com/#sle.

c. SPP Pumps, Inc; _____: www.spppumps.com/#sle.

2. UL 448 and UL 778; vertical- or horizontal-mounted, single-stage, close-coupled centrifugal pump for maximum working pressure of 186 psi (1,282 kPa).
3. Casing: Cast or ductile iron, or bronze with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
4. Impeller: Bronze, fully enclosed, keyed directly to motor shaft.
5. Shaft: Solid alloy steel with bronze sleeve.
6. Seal: Carbon rotating against a stationary ceramic seat viton fitted, 225 degrees F (107 degrees C) maximum continuous operating temperature.
7. Performance: As Scheduled on the Drawings.

2.2 ELECTRIC MOTOR DRIVE:

A. Motor: Squirrel cage induction type, NEMA MG 00001; in open drip-proof NEMA EN 10250 enclosure, 3,500 rpm; see Section 21 05 13.

B. Controller: Limited service type with auto-transformer starter, in NEMA EN 10250 enclosure, including the following:

1. Disconnect Switch: Externally operable, quick break type.

2. Circuit Breaker: Comply with NFPA 20; minimum 65,000 amperes interrupting capacity.
3. Motor Starter: Energized automatically through pressure switch or manually by externally operable handle.
4. Pressure Switch: Set to cut in at _____ psi (_____ kPa).
5. Running Period Timer: Keeps motor in operation when started automatically, for a minimum of seven minutes.
6. Pilot Lamp: Indicates circuit breaker closed and power available.
7. Alarm Relay: Energizes alarm to indicate circuit breaker open or power failure.
8. Switch Relay: For remote start.
9. Manual Selector Station: On enclosure marked "Automatic" and "Non-Automatic".

2.3 JOCKEY PUMP

A. Manufacturers:

1. Armstrong Fluid Technology; _____: www.armstrongfluidtechnology.com//#sle.
2. Grundfos Pumps Corporation: www.grundfos.com/us/#sle.
3. Pentair Aurora; PVM(X) Series: www.pentair.com/#sle.

B. Electrically operated, horizontal or vertical, single or multi stage, turbine type centrifugal pump with standard open drip-proof horizontal motor.

C. Control by automatic jockey pump controller with full voltage starter and minimum run timer to start pump on pressure drop in system and stay in operation for minimum period of time. Fire pump shall start automatically on further pressure drop or on jockey pump failure.

D. Performance: As Scheduled on the Drawings.

1. Capacity: _____ gpm (_____ L/sec) at _____ feet of head (_____ kPa).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 20.

B. Provide access space around pumps for service; no less than minimum as recommended by manufacturer.

C. Piping: Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For base mounted pumps, provide supports under elbows on pump suction and discharge; see Section 21 05 00.

D. Provide drains for bases and seals, piped to and discharging into floor drains.

E. Mount unit on vibration isolators; ~~see Section 21 05 48~~.

F. Provide for connection to electrical service; see Section 26 05 83.

G. Lubricate pumps before start-up.

H. Check, align, and certify pumps by qualified installer prior to start-up.

I. Provide supervisory alarm notifications using auxiliary dry contacts interconnected into fire alarm system for monitoring by Owner-designated central or off-site point of constant attendance; see Section 28 46 00.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Perform hydrostatic tests, flushing, and field acceptance tests as specified in NFPA 20.

3.3 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals for additional submittals.

B. See Section 01 79 00 - Demonstration and Training for additional requirements.

C. Demonstrate automatic operation of system including verification of pressure switch set points to Owner.

D. Use operation and maintenance data as reference during demonstration.

E. Briefly describe function, operation, and maintenance of each component.

F. Conduct walking tour of project.

G. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

END OF SECTION 21 30 00

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.2 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015, with Errata (2026).

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.

C. NEMA MG 00001 - Motors and Generators; 2024.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of high efficiency motors.

1.5 DELIVERY, STORAGE, AND HANDLING

A. 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 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Construction:

1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F (40 degrees C) environment.
3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.

B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

C. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.2 APPLICATIONS

2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

D. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. 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.

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. 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.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 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.

2.7 ELECTRONICALLY COMMUTATED MOTORS (ECM)

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with 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 ensure agreement with nameplate.

END OF SECTION 22 05 13

SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pressure gauges.

B. Thermometers.

1.2 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.

PART 2 PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers:

1. Ashcroft, Inc; _____: www.ashcroft.com/#sle.
2. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
3. Weksler Glass Thermometer Corp; _____: www.wekslerglass.com/#sle.
4. Winters Instruments; _____: www.winters.com/#sle.

B. Bourdon Tube for Liquids and Gases:

1. Dial Size and Cover: 4-1/2 inch (115 mm) diameter scale with polycarbonate window.
2. Dial Text and Markings: Black color on white background with scaled kPa and psi units.
3. Accuracy: ASME B40.100, adjustable commercial grade (D) with 5 percent of span.
4. Process Connection: Lower-back, 1/4 inch (8 mm, DN) NPT male except where noted.
5. Gauge Wetted Materials: Painted steel case and brass socket rated to match process pressure and temperature range.

C. Accessories:

1. Gauge Cock: Carbon steel with tee or lever handle for maximum 150 psi (1034 kPa).
2. Needle Valve: Carbon steel, 1/4 inch (6 mm, DN) NPT female for noncorrosive service.

2.2 THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
2. Moeller Instrument Company, Inc; _____: www.moellerinstrument.com/#sle.
3. Watts Water Technologies, Inc; _____: www.watts.com/#sle.
4. Weiss Instruments, LLC; _____: www.weissinstruments.com/#sle.
5. Weksler Glass Thermometer Corp; _____: www.wekslerglass.com/#sle.
6. Winters Instruments; _____: www.winters.com/#sle.

B. General:

1. Product Compliance: ASTM E1.
2. Lens: Clear glass, except where stated.
3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.

C. Thermometers - Adjustable Angle: 7 inch (177.8 mm) v-shape aluminum case with clear glass window scale, 6 inch (152.4 mm) NPT stem, red or blue organic non-toxic liquid filled glass tube, and adjustable joint with positive locking device allowing 360 degrees in horizontal plane or 180 degrees in vertical plane adjustments.

D. Thermometers - Dial Type:

1. Fixed: 5 inch (125 mm) diameter dial with black pointer, stainless steel case, silicone damping bimetal element, hermetically sealed lens, recalibrating screw, and 2-1/2 inch (63.5 mm) NPT stem.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports, and test plugs.

3.2 INSTALLATION

A. Install pressure gauges as follows:

1. At Pumps: Place single gauge before strainer, suction side and discharge side.
2. Include gauge cock to isolate each gauge and extend nipples for insulation clearance.
3. Include siphons on high temperature systems and select type according to service rating.
4. Adjust gauges to selected viewing angle, clean thoroughly, and calibrate to zero.

B. Install thermometers as follows:

1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.

2. Piping: Install thermometers in branch butt weld connection fitting or socket-weld thermowell. Enlarge pipes smaller than 2-1/2 inch (60 mm) to accommodate sockets. Ensure sockets are above insulation clearance.

3.3 SCHEDULES

A. Pressure Gauges, Location and Scale Range:

1. Pumps, 0 to ____ psi (0 to ____ kPa).
2. Expansion tanks, 0 to ____ psi (0 to ____ kPa).
3. Pressure reducing valves, 0 to ____ psi (0 to ____ kPa).
4. Backflow preventers, 0 to ____ psi (0 to ____ kPa).

B. ~~Dial~~ Thermometers~~, Location and~~ Scale Range:

1. ~~Each supply air zone~~Inlet and outlet of domestic water heaters, 0 to ____ degrees F (0 to ____ degrees C).

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Ball valves.

B. Butterfly valves.

C. Check valves.

D. Gate valves.

E. Globe valves.

1.2 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Non-rising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. WOG: Water, oil, and gas.

J. WSP: Working steam pressure.

1.3 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

C. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

E. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2025.

F. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

G. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.

H. MSS SP-67 - Butterfly Valves; 2022.

I. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.

J. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.

K. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.

L. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

M. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.

N. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.5 QUALITY ASSURANCE

A. Manufacturer:

1. Obtain valves for each valve type from single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
2. Protect valve parts exposed to piped medium against rust and corrosion.
3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
5. Secure check valves in either the closed position or open position.
6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:

1. Maintain valve end protection and protect flanges and specialties from dirt.

a. Provide temporary inlet and outlet caps.

b. Maintain caps in place until installation.

2. Store valves in shipping containers and maintain in place until installation.

a. Store valves indoors in dry environment.

b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

PART 2 PRODUCTS

2.1 APPLICATIONS

A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

B. Provide the following valves for the applications if not indicated on drawings:

1. Shutoff: Ball, butterfly, gate or plug.
2. Dead-End: Single-flange butterfly (lug) type.
3. Throttling: Provide globe, angle, ball, or butterfly.
4. Swing Check (Pump Outlet):

a. 2 inch (50 mm, DN) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

b. 2-1/2 inch (65 mm, DN) and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.

C. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.

D. Required Valve End Connections for Non-Wafer Types:

1. Copper Tube:

a. 2 inch (50 mm, DN) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

b. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.

E. Domestic, Hot and Cold Water Valves:

1. 2 inch (50 mm, DN) and Smaller:

a. Bronze and Brass: Provide with solder-joint ends.

b. Ball: One piece, full port, brass with brass trim.

c. Bronze Swing Check: Class 125, bronze disc.

2. 2-1/2 inch (65 mm, DN) and Larger:

a. Iron Ball: Class 150.

b. Iron Single-Flange Butterfly: 200 CWP, EPDM seat, aluminum-bronze disc.

c. Iron Swing Check: Class 125, metal seats.

d. Iron Gate: Class 125, NRS.

e. Iron Globe: Class 125.

2.2 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:

1. Handwheel: Valves other than quarter-turn types.
2. Hand Lever: Quarter-turn valves 6 inch (150 mm, DN) and smaller except plug valves.

D. Insulated Piping Valves: With 2 inch (50 mm, DN) stem extensions and the following features:

1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: Extended neck.

E. Valve-End Connections:

1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Solder Joint Connections: ASME B16.18.

F. General ASME Compliance:

1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
2. Solder-joint Connections: ASME B16.18.

G. Source Limitations: Obtain each valve type from a single manufacturer.

2.3 BRASS, BALL VALVES

A. Two Piece, Full Port with Brass Trim and Female Thread, Male thread, or Solder Connections:

1. Comply with MSS SP-110.
2. WSP Rating: 150 psi (1035 kPa).
3. WOG Rating: 600 psi (4140 kPa).
4. Body: Forged brass.
5. Seats: PTFE.
6. Ball: Chrome-plated brass.
7. Operator: Lockable handle and memory stop.

2.4 IRON, BALL VALVES

A. Class 125, Full Port, Stainless Steel Trim:

1. Comply with MSS SP-72.
2. CWP Rating: 200 psi (1380 kPa).
3. Body: ASTM A536 Grade 65-45-12, ductile iron.
4. End Connections: Flanged.

5. Seats: PTFE.
6. Ball: Stainless steel.
7. Operator: Lever with locking handle.

2.5 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Wafer and Lug Style:

1. Class 125, or Class 150 flanges.
2. Comply with MSS SP-67, Type I.
3. Wafer Style, Service Pressure Ratings:
    a. 150 psi (1034 kPa) for sizes 14 to 24 inch (350 to 600 mm, DN).
    b. 200 psi (1380 kPa) for sizes 2 to 12 inch (50 to 300 mm, DN).
4. Lug Style, Service Pressure Ratings:
    a. 150 psi (1034 kPa) for sizes 14 to 24 inch (350 to 600 mm, DN).
    b. 250 psi (1725 kPa) for sizes 2 to 12 inch (50 to 300 mm, DN).
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Stem: One or two-piece stainless steel.
7. Seat: EPDM.
8. Disc: Aluminum-bronze.
9. Finish: Epoxy coated.
10. Operator: Lockable handle over direct-mount actuator base.

2.6 BRONZE, LIFT CHECK VALVES

A. General:

1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:

1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
2. CWP Rating: 200 psi (1380 kPa).
3. Design: Vertical flow.
4. Body: Bronze.
5. End Connections: Threaded.
6. Disc (Type 1): Bronze.

2.7 BRASS, INLINE CHECK VALVES

A. Class 150:

1. WOG Rating: 200 psi (1380 kPa).
2. Maximum Service Temperature: 250 degrees F (121.1 degrees C).
3. Body: Forged brass.
4. Disc: Forged brass.

5. Seal: PTFE, bubble-tight.
6. End Connections: Press.

2.8 BRASS, HORIZONTAL SWING CHECK VALVES

A. Class 125, Threaded End Connections:

1. WOG Rating: 200 psi (1380 kPa).
2. Body: Forged brass.
3. Disc: Forged brass.
4. Hinge-Pin, Screw, and Cap: Forged brass.

2.9 BRONZE, SWING CHECK VALVES

A. General:

1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:

1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. WOG Rating: 200 psi (1380 kPa).
4. Body: Bronze.
5. End Connections: Threaded.
6. Disc: Bronze.

2.10 IRON, HORIZONTAL SWING CHECK VALVES

A. Class 125:

1. Pressure and Temperature Rating: MSS SP-71, Type I.
2. Design: T-body style for clear or full waterways.
3. WOG Rating: 200 psi (1380 kPa).
4. Body: ASTM A126, gray cast iron with bolted bonnet.
5. End Connections: Flanged.
6. Trim: Composition.
7. Seat Ring and Disc Holder: Bronze.
8. Disc: PTFE.
9. Gasket: Asbestos free.

2.11 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125 with Lever and Spring-Closure Control.

1. Comply with MSS SP-71, Type I.
2. Description:

a. CWP Rating: 200 psi (1380 kPa).

b. Design: Clear or full waterway.

c. Body: ASTM A126, gray iron with bolted bonnet.

d. Ends: Flanged as indicated.

e. Trim: Bronze.

f. Gasket: Asbestos free.

g. Closer Control: Factory installed, exterior lever, and weight.

2.12 IRON, GATE VALVES

A. Bolted Bonnet: OS&Y; Rising Stem:

1. Pressure and Temperature Rating: MSS SP-70, Type I.
2. Class 125: WOG Rating; 200 psi (1380 kPa).
3. Body: ASTM A126, gray iron with bolted bonnet.
4. End Connections: Flanged.
5. Trim: Bronze.
6. Disc: Solid wedge.
7. Packing and Gasket: Asbestos free.

2.13 IRON, GLOBE VALVES

A. ~~Class 125 and Class 250~~Class 125:

1. Class 125, WOG Rating: 200 psi (1380 kPa).
2. Comply with MSS SP-85, Type I.
3. Body: Gray iron; ASTM A126, with bolted bonnet.
4. Connection Ends: Flanged.
5. Trim: Bronze.
6. Packing and Gasket: Asbestos free, adjustable.
7. Operator: Handwheel or chainwheel.
8. Pressure and Temperature Rating: ASME B16.1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.2 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install check valves where necessary to maintain direction of flow as follows:

1. Lift Check: Install with stem plumb and vertical.
2. Swing Check: Install horizontal maintaining hinge pin level.
3. Orient plate-type into horizontal or vertical position, between flanges.

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Prefabricated trapeze-framed systems.

B. Strut systems for pipe or equipment support.

C. Beam clamps.

D. Pipe hangers.

E. Pipe supports, guides, shields, and saddles.

F. Anchors and fasteners.

1.2 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications.

1.3 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2025.

D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.

E. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).

F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

H. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

K. MFMA-4 - Metal Framing Standards Publication; 2004.

L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

M. UL (DIR) - Online Certifications Directory; Current Edition.

N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.

B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.

C. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.

1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.

D. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.

2.2 PREFABRICATED TRAPEZE-FRAMED SYSTEMS

A. Prefabricated Trapeze-Framed Metal Strut Systems:

1. Manufacturers:

a. Anvil International, LLC; _____: www.asc-es.com/#sle.

b. Gripple, Inc; Fast Track - Standard: www.gripple.com/#sle.

c. Unistrut, a brand of Atkore International, Inc; _____: www.unistrut.com/#sle.

2. MFMA-4 compliant, prefabricated, side-loading continuous-slot metal strut channel bracket with associated tracks, fittings, and related accessories.
3. Strut Channel or Bracket Material:

a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.

b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.

4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm).
5. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
6. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

2.3 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

A. Strut Channels:

1. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
2. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

B. Hanger Rods:

1. Threaded zinc-plated steel unless otherwise indicated.
2. Minimum Size, Unless Otherwise Indicated or Required:

a. Equipment Supports: 1/2 inch (13 mm, DN) diameter.

b. Piping up to 1 inch (25 mm, DN): 1/4 inch (6 mm, DN) diameter.

c. Piping larger than 1 inch (25 mm, DN): 3/8 inch (10 mm, DN) diameter.

d. Trapeze Support for Multiple Pipes: 3/8 inch (10 mm) in length.

C. Channel Nuts:

1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

2.4 BEAM CLAMPS

A. C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.

B. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).

C. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.

D. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

E. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2.5 PIPE HANGERS

A. Clevis Hangers, Adjustable:

1. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.
2. Standard-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.

2.6 PIPE CLAMPS

A. Riser Clamps:

1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch (15 to 200 mm, DN).

2.7 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

A. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

B. Pipe Shields for Insulated Piping:

1. MSS SP-58 type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
2. General Construction and Requirements:

a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.

b. Shields Material: UV-resistant polypropylene with glass fill.

c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch (321 mm).

d. Service Temperature: Minus 40 to 178 degrees F (Minus 40 to 81 degrees C).

e. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

C. Pipe Supports:

1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up to 122 degrees F (50 degrees C):

a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.

b. Support From Below: MSS SP-58 types 35 through 38.

D. Pipe Supports, Thermal Insulated:

1. General Requirements:

a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.

c. Provide pipe supports for 1/2 to 30 inch (15 to 750 mm, DN) iron pipes.

d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by 360 degree, PVC jacketing.

2. PVC Jacket:

a. Pipe insulation protection shields to be provided with ball bearing hinge and locking seam.

b. Moisture Vapor Transmission: 0.0071 perm inch (0.0092 ng/Pa s m), when tested in accordance with ASTM E96/E96M.

c. Minimum Thickness: 60 mil, 0.06 inch (1.524 mm).

2.8 ANCHORS AND FASTENERS

A. Manufacturers - Mechanical Anchors:

1. Hilti, Inc; _____: www.us.hilti.com/#sle.
2. ITW Red Head, a division of Illinois Tool Works, Inc; _____: www.itwredhead.com/#sle.
3. Simpson Strong-Tie Company Inc; _____: www.strongtie.com/#sle.

B. Manufacturers - Powder-Actuated Fastening Systems:

1. Hilti, Inc; _____: www.us.hilti.com/#sle.
2. Simpson Strong-Tie Company Inc; _____: www.strongtie.com/#sle.

C. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

D. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

E. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.

F. Steel: Use beam ceiling clamps, beam clamps, machine bolts, or welded threaded studs.

G. Preset Concrete Inserts: Continuous metal strut channel and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Channel Material: Use galvanized steel.
2. Manufacturer: Same as manufacturer of metal strut channel framing system.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

G. Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

I. Secure fasteners according to manufacturer's recommended torque settings.

J. Remove temporary supports.

END OF SECTION 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Ceiling tacks.

1.2 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting: Identification painting.

1.3 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2025.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Schedules:

1. Submit plumbing component identification schedule listing equipment, piping, and valves.
2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
3. Valve Data Format: Include id-number, location, function, and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.1 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

A. Nameplates:

1. Heat exchangers, water heaters, and other heat transfer products.
2. Control panels, transducers, and other related control equipment products.
3. Pumps, tanks, filters, water treatment devices, and other plumbing equipment products.

B. Tags:

1. Piping: 3/4 inch (20 mm) diameter and smaller.
2. Manual operated and automated control valves.
3. Ceiling tacks placed on lay-in ceiling surface to reference plumbing components.

C. Pipe Markers: 3/4 inch (20 mm) diameter and higher.

2.2 NAMEPLATES

A. Description: Laminated piece with up to three lines of text.

1. Letter Color: White.
2. Letter Height: 1/4 inch (6 mm).
3. Background Color: Black.
4. Nameplate Height: 3/4 inch (19 mm).
5. Nameplate Material:

a. Flexible: Vinyl with adhesive backing per ASTM D709.

b. Metal: Brass with center-side holes for screw fastening.

2.3 TAGS

A. Metal: Brass, 19 gauge 1-1/2 inch (40 mm) in diameter with smooth edges, blank, smooth edges, and corrosion-resistant ball chain. Up to three lines of text.

B. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.

2.4 PIPE MARKERS

A. Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.

B. Flexible Tape Marker: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

C. Identification Scheme, ASME A13.1:

1. Primary: External Pipe Diameter, Uninsulated or Insulated.

a. 3/4 to 1-1/4 inches (19 to 32 mm): Use 8 inch (203 mm) field-length with 1/2 inch (13 mm) text height.

b. 1-1/2 to 2 inches (38 to 51 mm): Use 8 inch (203 mm) field-length with 3/4 inch (19 mm) text height.

c. 2-1/2 to 6 inches (64 to 152 mm): Use 12 inch (305 mm) field-length with 1-1/4 inch (32 mm) text height.

2. Secondary: Color scheme per fluid service. Coordinate with industry standards.

a. Compressed Air: White text on blue background.

b. Flammable and Oxidizing Fluids: Black text on yellow background.

c. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.

2.5 CEILING TACKS

A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive identification products.

3.2 INSTALLATION

A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags in clear view and align with axis of piping

C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Install plastic tape pipe marker around pipe in accordance with manufacturer's instructions.

E. Apply ASME A13.1 Pipe Marking Rules:

1. Place pipe marker adjacent to changes in direction.
2. Place pipe marker adjacent each valve port and flange end.
3. Place pipe marker at both sides of floor and wall penetrations.
4. Place pipe marker every 25 to 50 feet (7.6 to 15.2 m) interval of straight run.

F. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Flexible elastomeric cellular insulation.

B. Glass fiber insulation.

C. Jacketing and accessories.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

1.3 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.

E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2025.

F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

G. ASTM C1393 - Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks; 2025.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER INSULATION

A. Manufacturers:

1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
2. Johns Manville Corporation; _____: www.jm.com/#sle.
3. Knauf Insulation: www.knaufinsulation.com/#sle.
4. Manson Insulation, a company of Knauf Insulation: www.imanson.com/#sle.
5. Owens Corning Corporation: www.owenscorning.com/en-us/#sle.

B. Insulation: ASTM C547 and ASTM C795; rigid, preformed pipe insulation, noncombustible.

1. K (Ksi) Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
2. Maximum Service Temperature: 850 degrees F (454 degrees C).
3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Insulation: ASTM C1393; pipe and tank, end grain adhered to jacket.

1. K (Ksi) Value: ASTM C177, 0.27 at 75 degrees F (0.034 at 24 degrees C).
2. Maximum Service Temperature: 850 degrees F (454 degrees C).
3. Maximum Moisture Absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm (0.029 ng/(Pa s m)).

E. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

F. Vapor Barrier Lap Adhesive: Compatible with insulation.

G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:

1. Aeroflex USA; AEROFLEX Self-Seal: www.aeroflexusa.com/#sle.
2. Armacell LLC; AP ArmaFlex: www.armacell.us/#sle.
3. K-Flex USA LLC; Insul-Tube: www.kflexusa.com/#sle.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.

1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
2. Maximum Service Temperature: 220 degrees F (104 degrees C).
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Weather Barrier: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.4 JACKETING AND ACCESSORIES

A. PVC Plastic Jacket:

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.

a. Minimum Service Temperature: 0 degrees F (Minus 18 degrees C).

b. Maximum Service Temperature: 150 degrees F (66 degrees C).

c. Moisture Vapor Permeability: 0.002 perm inch (0.0029 ng/(Pa s m)), maximum, when tested in accordance with ASTM E96/E96M.

d. Thickness: 10 mil, 0.010 inch (0.25 mm).

e. Connections: Brush on welding adhesive.

B. Aluminum Jacket:

1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
4. Fittings: 0.016 inch (0.40 mm) thick die-shaped fitting covers with factory-attached protective liner.
5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.

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. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

D. 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.

E. For hot piping conveying fluids 140 degrees F (60 degrees C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

F. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.

G. 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.

H. Inserts and Shields:

1. Application: Piping 1-1/2 inches (40 mm) diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert Location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with canvas jacket sized for finish painting.

K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 SCHEDULES

A. Plumbing Systems:

1. Domestic Hot Water Supply:

a. Glass Fiber Insulation:

1) Pipe Size Range: ~~[____] inch ([____] mm)~~1-1/4 inch (____ mm)~~.~~and smaller.

(a) Thickness: ~~[____] inch ([____] mm)~~1 inch (____ mm).

2) Pipe Size Range: 1-1/2 inch and larger.

(a) Thickness: 1-1/2 inch.

2. Domestic Hot Water Recirculation:
    a. Glass Fiber Insulation:
        1) Pipe Size Range: All sizes.
        2) Thickness: 1 inch (25 mm).
3. Domestic Cold Water:
    a. Glass Fiber Insulation:
        1) Pipe Size Range: 1-1/4 inch and smaller.
            (a) Thickness: 1/2 inch.
        2) Pipe Size Range: 1-1/2 inch and larger.
            (a) Thickness: 1 inch.

END OF SECTION 22 07 19

SECTION 22 10 05 - PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sanitary waste piping, buried within 5 feet (1500 mm) of building.

B. Sanitary waste piping, above grade.

C. Domestic water piping, buried within 5 feet (1500 mm) of building.

D. Domestic water piping, above grade.

E. Propane gas piping, above grade.

F. Pipe flanges, unions, and couplings.

G. Pipe hangers and supports.

1.2 RELATED REQUIREMENTS

A. Section 08 31 00 - Access Doors and Panels.

B. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.

C. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

E. Section 31 23 16 - Excavation.

F. Section 31 23 23 - Fill.

1.3 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

D. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.

E. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.

F. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings; 2021.

G. ASME B31.1 - Power Piping; 2024.

H. ASME B31.9 - Building Services Piping; 2025.

I. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

J. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.

K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.

L. ASTM B32 - Standard Specification for Solder Metal; 2020.

M. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

N. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

O. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2026.

P. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.

Q. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.

R. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.

S. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.

T. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).

U. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2025.

V. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).

W. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).

X. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2026.

Y. AWWA C651 - Disinfecting Water Mains; 2023.

Z. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.

AA. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.

BB. FM 1680 - Examination Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/ Commercial and Residential; 2025.

CC. IAPMO (UPC) - Uniform Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

DD. IAPMO/ANSI/CAN Z1117 - Standard for Press Connections; 2022.

EE. ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

FF. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

GG. NFPA 58 - Liquefied Petroleum Gas Code; 2024, with Amendment.

HH. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

II. NSF 372 - Drinking Water System Components - Lead Content; 2024.

JJ. PPI TR-4 - PPI HSB Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe; 2024.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Project Record Documents: Record actual locations of valves.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. 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 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, solder, and flux (if used), complying with NSF 61 and NSF 372; label pipe and fittings.

2.2 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Cast Iron Pipe: ASTM A74 extra heavy weight.

1. Fittings: Cast iron.
2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hubless.

1. Fittings: Cast iron.
2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

C. Copper Tube: ASTM B306, DWV.

1. Fittings: ASME B16.23, cast copper, or ASME B16.29, wrought copper.
2. Joints: ASTM B32, alloy Sn50 solder.

D. PVC Pipe: ASTM D2665 or ASTM D3034.

1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.3 SANITARY WASTE PIPING, ABOVE GRADE

A. Copper Tube: ASTM B306, DWV.

1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, sovent.
2. Joints: ASTM B32, alloy Sn50 solder.

B. PVC Pipe: ASTM D2665.

1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.4 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.

1. PPI TR-4 Pressure Design Basis:
2. PEX Type, Fittings, and Joints:

a. PEX-a, Engle method or PEX-b, Silane method; no fittings; use continuous runs of piping.

2.5 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Pipe: ASTM B88 (ASTM B88M), Type L (Type B), drawn temper.

1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
2. Joints: ASTM B32 solder.
3. Mechanical Press Sealed Fittings: ASME B16.51 or IAPMO/ANSI/CAN Z1117, ICC (IPC), and IAPMO (UPC) approved, NSF 61 and NSF 372 certified, with EPDM seals.

a. Manufacturers:

1) Apollo Valves; _____: www.apollovalves.com/#sle.

2) Mueller Streamline, Co; PRS: www.muellerstreamline.com/#sle.

3) NIBCO INC; Press System: www.nibco.com/#sle.

4) _____.

2.6 PROPANE GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
2. Joints: NFPA 58, threaded or welded to comply with ASME B31.1.

2.7 PIPE FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 inch (80 mm, DN) and Under:

1. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Sizes Over 1 inch (25 mm, DN):

1. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Shielded, Heavy Duty No-Hub Couplings:

1. Testing: In accordance with ASTM C1540 and FM 1680.
2. Gasket Material: Neoprene complying with ASTM C564.
3. Band Material: Stainless steel.
4. Eyelet Material: Stainless steel.

2.8 PIPE HANGERS AND SUPPORTS

A. See Section 22 05 29 for additional requirements.

B. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.

C. Plumbing Piping - Drain, Waste, and Vent:

1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm, DN): Malleable iron, adjustable swivel, split ring.
2. Hangers for Pipe Sizes 2 inch (50 mm, DN) and Over: Carbon steel, adjustable, clevis.

D. Plumbing Piping - Water:

1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm, DN): Malleable iron, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 inch (50 mm, DN) and Over: Carbon steel, adjustable, clevis.

3. Hangers for Hot Pipe Sizes 2 to 4 inch (50 to 100 mm, DN): Carbon steel, adjustable, clevis.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 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.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 22 05 16.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

H. Provide access where valves and fittings are not exposed.

1. Coordinate size and location of access doors with Section 08 31 00.

I. Provide support for utility meters in accordance with requirements of utility companies.

J. Excavate in accordance with Section 31 23 16.

K. Backfill in accordance with Section 31 23 23.

L. Install bell and spigot pipe with bell end upstream.

M. Install valves with stems upright or horizontal, not inverted. See Section 22 05 23.

N. Install water piping to ASME B31.9.

O. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

P. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

Q. Sleeve pipes passing through partitions, walls, and floors.

R. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9.
2. Support horizontal piping as indicated.
3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
4. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

3.4 APPLICATION

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

B. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Provide spring-loaded check valves on discharge of water pumps.

D. Provide flow controls in water recirculating systems where indicated.

3.5 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch (10 mm) vertically of location indicated and slope to drain at minimum of 1/4 inch per foot (1:50) slope.

3.6 FIELD TESTS AND INSPECTIONS

A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.

B. Domestic Water Systems:

1. Perform hydrostatic testing for leakage prior to system disinfection.
2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
3. General:

a. Fill the system with water and raise static head to 10 psi (345 kPa) above service pressure. Minimum static head of 50 to 150 psi (345 to 1,034 kPa). As an exception, certain codes allow a maximum static pressure of 80 psi (551.6 kPa).

C. Gas Distribution Systems:

1. Test Preparation: Close each appliance valve or disconnect and cap each connected appliance.
2. General Systems:

a. Inject a minimum of 10 psi (68.9 kPa) of compressed air into the piping system for a duration of 15 minutes and verify with a gauge that no perceptible pressure drop is measured.

b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound (0.45 kg).

D. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.7 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed, and clean.

B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.8 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve, and sand strainer.

3.9 SCHEDULES

A. Pipe Hanger Spacing:

1. Metal Piping:

a. Pipe Size: 1/2 inch (15 mm, DN) to 1-1/4 inch (32 mm, DN):

1) Maximum Hanger Spacing: 6.5 ft (2 m).

2) Hanger Rod Diameter: 3/8 inches (9 mm).

b. Pipe Size: 1-1/2 inch (40 mm, DN) to 2 inch (50 mm, DN):

1) Maximum Hanger Spacing: 10 ft (3 m).

2) Hanger Rod Diameter: 3/8 inch (9 mm).

c. Pipe Size: 2-1/2 inch (65 mm, DN) to 3 inch (80 mm, DN):

1) Maximum Hanger Spacing: 10 ft (3 m).

2) Hanger Rod Diameter: 1/2 inch (13 mm).

2. Plastic Piping:

a. All Sizes:

1) Maximum Hanger Spacing: 6 ft (1.8 m).

2) Hanger Rod Diameter: 3/8 inch (9 mm).

END OF SECTION 22 10 05

SECTION 22 11 13 - FACILITY WATER DISTRIBUTION PIPING

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.

1.2 SUMMARY

A. This section includes all work to distribute water including but not limited to the following:

1. New Water Main.
2. New fire-protection/sprinkler service.
3. New domestic water service.

B. Related sections:

1. See other related Division 22 sections for additional requirements governing water service connections within the building.
2. Division 31 Section "Earth Moving for Utilities" for soil materials, excavating, backfilling.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)
2. ANSI B16.1 2005 Cast Iron Pipe Flanges and Flanged Fittings
3. ANSI B16.18 2001 Cast Copper Alloy Solder Joint Pressure Fittings
4. ANSI B16.22 2001 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
5. ANSI B16.26 2006 Cast Copper Alloy Fittings for Flared Copper Tubes
6. ANSI B18.2.2 1987 Square and Hex Nuts
7. ANSI B18.5 2008 Round Head Bolts (Inch Series)
8. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
9. ASTM A47 1999 Ferritic Malleable Iron Castings
10. ASTM A48 2008 Gray Iron Castings
11. ASTM A307 2002 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
12. ASTM A536 1984 (Rev 1999) Ductile Iron Castings
13. ASTM A563 2007 Carbon and Alloy Steel Nuts
14. ASTM B32 2008 Solder Metal
15. ASTM B61 2008 Steam or Valve Bronze Castings
16. ASTM B62 2002 Composition Bronze or Ounce Metal Castings
17. ASTM B88 2003 Seamless Copper Water Tube
18. ASTM C94 2009 Ready-Mixed Concrete
19. AMERICAN WATER WORKS ASSOCIATION (AWWA)
20. AWWA C104/A21.4 2008 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water (ANSI/AWWA C104/A21.4)
21. AWWA C105/A21.5 2005 Polyethylene Encasement for Ductile-Iron Pipe Systems

22. AWWA C110/A21.10 2008 Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in.
23. AWWA C111/A21.11 2006 Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
24. AWWA C115/A21.15 2005 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
25. AWWA C151/A21.51 2002 Ductile-Iron Pipe, Centrifugally Cast, for Water
26. AWWA C153/A21.53 2006 Ductile Iron Compact Fittings for Water Service
27. AWWA C500 2002 Gate Valves for Water and Sewage Systems
28. AWWA C502 2005 Dry-Barrel Fire Hydrants
29. AWWA C503 2005 Wet-Barrel Fire Hydrants
30. AWWA C509 2001 Resilient-Seated Gate Valves for Water Supply Service
31. AWWA C600 2005 Installation of Ductile-Iron Water Mains and Their Appurtenances
32. AWWA C651 2005 Disinfecting Water Mains
33. AWWA C800 2005 Underground Service Line Valves and Fittings
34. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)
35. MSS SP-80 2003 Bronze Gate, Globe, Angle and Check Valves
36. UNDERWRITERS LABORATORIES, INC. (UL)
37. UL 246 1993 Hydrants for Fire-Protection Service
38. UL 262 2004 Gate Valves for Fire Protection Service

1.4 PROJECT CONDITIONS

A. Water Main Work: Work under Section 221113 shall include the following:

1. Installation of water main starting at the connection to the existing main or other supply main and continuing up to the end location as indicated on the Drawings. Work shall also include all piping, fittings, valves, concrete thrust blocks with restraining rods from elbow, all as indicated. Work also to include all flushing and testing.
2. Earthwork for the water main work shall follow Section 312100. Where appropriate, provide final grading and loam, seed, and paving as indicated or to match existing features and restore surfaces to original conditions.

B. Water Service: Work under Section 221113 shall include the following:

1. Installation of water main and water service line starting at the street main or other supply line, continuing up to the end location as indicated otherwise on Drawings. Work shall include all piping, fittings, valves, thrust blocks indicated. Work shall include flushing and testing.
2. Exterior water line work shall follow Section 312100. Where appropriate provide final grading and loam seed and paving as indicated or to match existing features and restore surfaces to original conditions.

C. Location: The work covered by this section shall terminate at a point approximately 10 feet from the building, unless otherwise indicated on the drawings.

D. The General Contractor shall be responsible for all fees and permits related to the connection to the existing municipal water main system.

1.5 DESIGN REQUIREMENTS

A. Water Distribution Mains: Provide water distribution mains of ductile-iron pipe. Provide gate valves where indicated. Provide water main accessories as indicated.

B. Water Service Lines: Provide water service lines from water distribution main to building. Water service lines shall be copper tubing. Provide water service line appurtenances where specified and where indicated.

1.6 SUBMITTALS

A. Submit the following in accordance with Section 013300, "Submittals."

B. Manufacturer's Catalog Data:

1. Pipe and fittings
2. Joints and couplings
3. Valves
4. Corporation stops
5. Valve boxes
6. Brass Wedges

C. Submit manufacturer's standard drawings or catalog cuts for the listed items, except submit both drawings and cuts for push-on joints. Include information concerning gaskets with submittal for joints and couplings

D. Manufacturer's Instructions

1. Installation procedures for water piping

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage: Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store jointing materials, and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

B. Handling: Handle pipe, fittings, valves, hydrants, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry, do not drag pipe to the trench. Store rubber gaskets and jointing materials that are not to be installed immediately, under cover out of direct sunlight.

PART 2 PRODUCTS

2.1 WATER DISTRIBUTION MAIN MATERIALS

A. Piping Materials:

1. Ductile-iron Piping

a. Pipe and Fittings: Pipe shall conform to AWWA C151/A21.51 and shall be Thickness Class 52. Flanged pipe shall conform to AWWA C115/A21.15. Fittings shall conform to AWWA C110/A21.10 or AWWA C153/A21.53; fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that the bell design shall be modified, as approved, for push-on joint. Fittings shall have pressure rating at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the specified joints. Pipe and fittings shall have cement-mortar lining conforming to AWWA C104/A21.4, double thickness; pipe and fittings to be bituminous coated per AWWA C104/A21.4.

b. Joints and Jointing Material

1) Joints: Joints for pipe and fittings shall be push-on joints.

2) Push-on Joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly shall conform to AWWA C111/A21.11.

3) Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets shall conform to AWWA C111/A21.11.

4) Flanged Joints: Bolts, nuts, and gaskets for flanged connections shall be as recommended in the Appendix to AWWA C115/A21.15. Flange for setscrewed flanges shall be of ductile iron, ASTM A536, Grade 65-45-12, and shall conform to the applicable requirements of ANSI B16.1, Class 250. Setscrews for setscrewed flanges shall be 190,000 psi tensile strength, heat treated and zinc-coated steel. Gasket for setscrewed flanges shall conform to the applicable requirements for mechanical-joint gaskets specified in AWWA C111/A21.11. Design of setscrewed gasket shall provide for confinement and compression of gasket when joint to adjoining flange is made.

B. Valves and Other Water Main Accessories

1. Gate Valves on Buried Piping: AWWA C500, to AWWA C509, or to UL 262. Unless otherwise specified, valves conforming to AWWA C500 shall be nonrising stem type with double-disc gates and mechanical-joint ends for the adjoining pipe. Unless specified otherwise, valves conforming to AWWA C509 shall be nonrising stem type with mechanical-joint ends. Unless otherwise specified, valves conforming to UL 262 shall be inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 175 psi, and shall have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined. Materials for UL 262 valves shall conform to the reference standards specified in AWWA C500. Valves shall open by right rotation of the valve stem. Stuffing boxes shall have 0-ring stem seals and shall be bolted and constructed so as to permit easy removal of parts for repair. Valves shall be of one manufacturer. Acceptable product/manufacturers are:

a. Mueller A2360

b. Approved Equal

2. Valve Boxes: Provide a valve box for each gate valve on buried piping. Valve boxes shall be of cast-iron of a size suitable for the valve on which it is to be used and shall be adjustable. Provide a round head. Cast the word "WATER" on the lid. The least diameter of the shaft of the box shall be 5 ¼ inches. Each cast-iron box shall have a heavy coat of bituminous paint.
3. Sleeve-type Mechanical Couplings: Design to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall provide for confinement and compression of the gaskets. Middle ring shall be of cast-iron and the follower rings shall be of malleable iron or ductile iron. Cast iron shall conform to ASTM A48 and shall be not less than Class 25. Malleable iron shall conform to ASTM A47. Ductile iron shall conform to ASTM A536. Gaskets shall be designed for resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts shall be track-head type; bolts and nuts shall be either of the following: bolts conforming to tensile requirements of ASTM A307, Grade A, with nuts conforming to tensile requirements of ASTM A563, Grade A; or round-head square-neck type bolts conforming to ANSI B18.5 with hex nuts conforming to ANSI B18.2.2. Bolts shall be 5/8-inch in diameter; minimum number of bolts for each coupling shall be as required for the application. Bolt holes in follower rings shall be of a shape to hold fast the necks of the bolts used. Do not use mechanically coupled joints using a sleeve-type mechanical coupling as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint

2.2 WATER SERVICE LINE MATERIALS

A. Piping Materials

1. Copper Tubing and Associated Fittings: Tubing shall conform to ASTM B88, Type K. Fittings for solder-type joint shall conform to ANSI B16.18 or ANSI B16.22; fittings for compression-type joint shall conform to ANSI B16.26, flared tube type. All brass fittings to be lead free.

B. Water Service Line Appurtenances

1. Corporation Stops: Ground key type; made of bronze conforming to ASTM B61 or ASTM B62; and suitable for the working pressure of the system. Ends shall be suitable for solder-joint, or flared tube compression type joint. Threaded ends for inlet and outlet of corporation stops shall conform to AWWA C800; coupling nut for connection to flared copper tubing shall conform to ANSI B16.26.
2. Goosenecks: Type K copper tubing. Joint ends for goosenecks shall be appropriate for connecting to corporation stop and service line. Length of goosenecks shall be in accordance with standard practice.
3. Curb or Service Stops: Ground key, round way, inverted key type; shall be made of bronze conforming to ASTM B61 or ASTM B62; and suitable for the working pressure

of the system. Ends shall be as appropriate for connection to the service piping. Arrow shall be cast into body of the curb or service stop indicating direction of flow.

4. Gate Valves Smaller Than 3-inch Size on Buried Piping: MSS SP80, Class 150, solid wedge, nonrising stem. Valves shall have flanged or threaded end connections, with a union on one side of the valve. Provide handwheel operators.
5. Curb Boxes: Provide for each curb or service stop. Curb boxes shall be of cast-iron of a size suitable for the stop on which it is to be used. Provide a round head with the word "WATER" cast on the lid. Each box shall have a heavy coat of bituminous paint.
6. Valve Boxes: Provide for each gate valve on buried piping. Valve boxes shall be of cast-iron of a size suitable for the valve on which it is to be used and shall be adjustable. Provide a round head. Cast the word "WATER" on the lid. The least diameter of the shaft of the box shall be 5 1/4 inches. Each cast-iron box shall have a heavy coat of bituminous paint.
7. All brass components shall be lead-free.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

A. General Requirements for Installation of Pipelines: These requirements shall apply to pipeline installation except where specific exception is made in the "Special Requirements..." paragraphs.

1. Location of Water Lines: The work covered by this section shall terminate at points as described in Part 1 of this Section and as indicated. Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer horizontally than 10 feet from any sewer line. Where water lines cross under gravity sewer lines, encase sewer line fully in concrete for a distance of at least 10 feet on each side of the crossing, unless sewer line is made of pressure pipe with rubber-gasketed joints and no joint is located within 3 feet horizontally of the crossing. Lay water lines which cross sewer force mains at least 2 feet above these sewer lines; when joints in the sewer line are closer than 3 feet horizontally from the water line, encase these joints in concrete. Do not lay water lines in the same trench with gas lines, fuel lines or electric wiring.
2. Earthwork: Perform earthwork operations in accordance with Section 312100.
3. Pipe Laying and Jointing: Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or other water line material into trenches. Cut pipe accurately to length established at the site and work into place without springing or forcing. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material. Blocking or wedging between bells and spigots will not be permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at proper elevation and grade, and secure firm, uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports where

indicated and where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been properly made. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevents installation. Install three (3) brass wedges at each bell prior to backfill.

4. Installation of Tracer Wire: Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.
5. Connections to Existing Lines: Contractor shall obtain and pay for fees and permits which may be required to connect to existing lines. After approval is obtained, make connections to existing water lines with a minimum interruption of service on the existing line. Make connections in accordance with the recommended procedures of the manufacturer of pipe of which the line being tapped is made. Contact the local utility company before making connections to the existing line. Follow criteria and regulations of the local utility when making connections to existing line.

B. Installation of Water Mains:

1. Special Requirements for Ductile-iron Piping Installation

a. Installation, General: Unless otherwise specified in the following subparagraphs, install pipe and fittings in accordance with paragraph entitled, "General Requirements for Installation of Pipelines" and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

b. Jointing:

1) Make push-on joints with the gaskets and lubricant previously specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.

2) Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and with the recommendations of Appendix A to AWWA C111/A21.11.

3) Make flanged joints with the gaskets, bolts, and nuts previously specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, and valves. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When any flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions. Use setscrewed flanges to make flanged joints where conditions prevent the use of full length flanged pipe; assemble in accordance with the recommendations of the setscrewed flange manufacturer. Setscrews shall

be either “Cor-Ten” steel, ductile iron or approved equal. Locking rings and Megalugs are acceptable replacements for retainer glands but are not a replacement for thrust blocks.

c. Pipe Anchorage: Provide concrete thrust blocks, reaction backing, for pipe anchorage. Thrust blocks shall be in accordance with the requirements of AWWA C600 for thrust restraint, except that size and positioning of thrust blocks shall be as indicated. Use concrete conforming to ASTM C94 having a minimum compressive strength of 3,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

2. Installation of Valves and Hydrants:

a. Installation of Valves: Install gate valves conforming to AWWA C500 and UL 262 in accordance with AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix (Installation, Operation, and Maintenance of Gate Valves) to AWWA C500. Install gate valves conforming to AWWA C509 in accordance with AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix (Installation, Operation, and Maintenance of Gate Valves) to AWWA C509. Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.

b. Installation of Hydrants: Install hydrants in accordance with AWWA C600 for hydrant installation and as indicated. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings.

C. Installation of Water Service Piping

1. Location: Connect water service piping to the building as described in Part 1 of this Section and as indicated.
2. Service Line Connections to Water Mains: Connect service lines to the main with a corporation stop and gooseneck and install a gate valve on service line below the frostline. Connections also to be as indicated. Connect service lines to ductile-iron water mains in accordance with AWWA C600 for service taps.
3. Special Requirements for Installation of Metallic Piping: Metallic Piping Installation, General: Install pipe and fittings in accordance with paragraph entitled, "General Requirements for Installation of Pipelines" and with the applicable requirements of AWWA C600 for pipe installation, unless otherwise specified.

a. Jointing:

1) Screwed Joints: Make screwed joints up tight with a stiff mixture of graphite and oil, inert filler and oil, or an approved graphite compound; apply to male threads only. Threads shall be full cut; do not leave more than three threads on the pipe exposed after assembling the joint.

2) Joints for Copper Tubing: Cut copper tubing with square ends; remove fins and burrs. Handle tubing carefully; replace dented, gouged, or otherwise damaged tubing with undamaged tubing. Make solder joints using ASTM

B32, 95-5 tin-antimony or Grade Sn96 solder. Solder and flux shall contain not more than 0.2 percent lead. Before making joint, clean ends of tubing and inside of fitting or coupling with wire brush or abrasive. Apply a rosin flux to the tubing end and on recess inside of fitting or coupling. Insert tubing end into fitting or coupling for the full depth of the recess and solder. For compression joints on flared tubing, insert tubing through the coupling nut and flare tubing with a flaring tool.

D. Disinfection: Flush and disinfect new potable water lines and affected portions of existing potable water lines in accordance with AWWA C651. Apply chlorine by the continuous feed method.

3.2 FIELD QUALITY CONTROL

A. Field Tests and Inspections: The Architect and/or its representative will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall produce evidence, when required, that any item of work has been constructed properly in accordance with the drawings and specifications. Do not begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 5 days after placing of the concrete.

B. Testing Procedure: Test water mains and water service lines in accordance with the applicable specified standard, except for the special testing requirements given in paragraph entitled "Special Testing Requirements." Test water service lines in accordance with applicable requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at copper tubing joints (soldered, compression type, brazed and screwed joints.

C. Special Testing Requirements: For pressure test, use a hydrostatic pressure 50 psi greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger than 2 inches in diameter, hydrostatic test pressure shall be 1.5 times the working pressure or not less than 125 psi whichever is greater. Hold this pressure for not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

D. Disinfection: Flush and disinfect new potable water lines/associated tanks and affected portions of existing potable water lines in accordance with AWWA C651. Apply chlorine by the continuous feed method.

END OF SECTION 22 11 13

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Backflow preventers.

B. Vacuum breakers.

C. Water pressure reducing valves.

D. Mixing valves.

E. Balancing valves.

F. Strainers.

G. Water-hammer arrestors.

H. Trap primers.

1.2 RELATED REQUIREMENTS

A. Section 22 05 19 - Meters and Gauges for Plumbing Piping: Thermometers, pressure gauges, and water meters.

B. Section 22 10 05 - Plumbing Piping: Pipe, fittings, and joints.

C. Section 26 05 83 - Wiring Connections.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's literature and data sheets for each product. Include information on materials of fabrication, assembly of components, dimensions, ratings, finishes, rough-in requirements, and installed accessories.

C. Manufacturer's Instructions: Provide for products listed below. Include instructions for handling, protection, examination, preparation, and installation.

1. Reduced-pressure-principle backflow preventers.
2. Double-check valve backflow preventers.
3. Thermostatic master mixing valves.
4. Electronic trap primer systems.

D. Operation and Maintenance Data: Provide for products listed below.

1. Reduced-pressure-principle backflow preventers.
2. Double-check valve backflow preventers.
3. Thermostatic master mixing valves.
4. Electronic trap primer systems.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

C. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

D. Store products under cover and protected from weather and dirt. Elevate above grade.

E. Protect end connections, flanges, threads, and grooves from dirt and damage.

F. Protect product interiors against rust and corrosion.

G. Do not use operating handles or stems as lifting or rigging points.

H. Handle large products using slings.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products complying with NSF 61 and NSF 372.

B. Source Limitations: Furnish domestic water piping specialties of same kind by same manufacturer.

C. Provide brass-bodied domestic water piping specialties in DZR brass.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. NPS 2 (DN 50) and Smaller:

a. Assembly: ASSE 1013 and AWWA C511.

b. Backflow Valve: Manufactured from bronze, copper silicon alloy, or stainless steel.

c. Isolation Valves: Ball valves on inlet and outlet.

d. Maximum Working Pressure: 175 psi (12.1 bar).

e. Working Temperature Range: 33 to 180 degrees F (0.5 to 82 degrees C).

f. Accessories:

1) Air gap fitting.

2) Inlet strainer.

2. NPS 2-1/2 (DN 65) and Larger:

a. Assembly: ASSE 1013 and AWWA C511.

b. Backflow Valve: Manufactured from epoxy-coated cast iron, epoxy-coated ductile iron, or stainless steel.

c. Isolation Valves: Epoxy-coated OS&Y valves on inlet and outlet.

d. Epoxy Coatings: AWWA C550.

e. Maximum Working Pressure: 175 psi (12.1 bar).

f. Working Temperature Range: 33 to 140 degrees F (0.5 to 60 degrees C).

g. Accessories:

1) Air gap fitting.

2) Inlet strainer.

B. Double-Check Valve Backflow Preventers:

1. NPS 2 (DN 50) and Smaller:

a. Assembly: ASSE 1015 and AWWA C510.

b. Check Valves: Manufactured from bronze, copper silicon alloy, or stainless steel.

c. Isolation Valves: Ball valves on inlet and outlet.

d. Maximum Working Pressure: 175 psi (12.1 bar).

e. Working Temperature Range: 33 to 180 degrees F (0.5 to 82 degrees C).

f. Accessories:

1) Inlet strainer.

2. NPS 2-1/2 (DN 65) and Larger:

a. Assembly: ASSE 1015 and AWWA C510.

b. Check Valves: Manufactured from epoxy-coated cast iron, epoxy-coated ductile iron, or stainless steel.

c. Isolation Valves: Epoxy-coated OS&Y valves on inlet and outlet.

d. Epoxy Coatings: AWWA C550.

e. Maximum Working Pressure: 175 psi (12.1 bar).

f. Working Temperature Range: 33 to 140 degrees F (0.5 to 60 degrees C) .

g. Accessories:

1) Inlet strainer.

2.3 VACUUM BREAKERS

A. Atmospheric Vacuum Breakers:

1. Valve: ASSE 1001, brass, bronze, or copper silicon alloy.
2. Maximum Working Pressure: 125 psi (8.6 bar).
3. Working Temperature Range: 33 to 180 degrees F (0.5 to 82 degrees C).

2.4 WATER PRESSURE REDUCING VALVES

A. Direct-Acting Pressure Reducing Valves:

1. Valve: ASSE 1003, bronze or copper silicon alloy body, with spring-loaded diaphragm; field-adjustable outlet pressure, and integral inlet screen strainer.

a. Diaphragm: EPDM or buna-nitrile.

b. Spring: Stainless steel.

c. Provide with single union ends.

2. Maximum Working Pressure: 300 psi (20.7 bar).
3. Outlet Pressure Range: 15 to 75 psi (100 to 515 kPa).
4. Working Temperature Range: 33 to 140 degrees F (0.5 to 60 degrees C).

2.5 MIXING VALVES

A. Thermostatic Master Mixing Valves:

1. Valve: ASSE 1017, brass or bronze body; thermostatic element; corrosion- and lime-resistant internal components; integral locking temperature adjustment.

a. Finish: Rough bronze.

2. Accessories:

a. Strainer stop checks on inlets.

b. Stem thermometer on outlet.

2.6 BALANCING VALVES

A. Calibrated Balancing Valves and Circuit Setters:

1. Valve: Brass, factory preset and calibrated, ball valve design, with metering ports, position indicator, and memory stop.
2. Maximum Working Pressure: 150 psi (10.3 bar).
3. Working Temperature Range: 33 to 200 degrees F (0.5 to 93 degrees C).

2.7 STRAINERS

A. NPS 2 (DN 50) and Smaller:

1. Body: Wye-pattern in brass, bronze, or copper silicon alloy.
2. Screen: Stainless steel mesh.
3. Pressure Rating: 200 psi (13.8 bar).

B. NPS 2-1/2 (DN 65) and Larger:

1. Body: Wye-pattern ductile iron, epoxy-coated cast iron, or epoxy-coated ductile iron,

a. Epoxy Coatings: AWWA C550 or FDA approved.

2. Screen: Perforated stainless steel.
3. Pressure Rating: 200 psi (13.8 bar).

2.8 WATER-HAMMER ARRESTORS

A. Piston Type:

1. Description: ASSE 1010 or PDI-WH 201, copper body with plastic piston and EPDM O-rings.
2. Air Preload Pressure: 60 psi (410 kPa).
3. Maximum Working Pressure: 150 psi (10.3 bar).
4. Working Temperature Range: 33 to 180 degrees F (0.5 to 82 degrees C).
5. Locate water hammer arrestors at all flush fixtures and all solenoid operated devices.
6. Size arrestors per PDI-WH-201.

2.9 TRAP PRIMERS

A. Water-Supplied Trap Primers (TP-1):

1. Description: ASSE 1018, bronze or brass body, water-supplied, pressure-drop activated trap primer with internal filter screen and integral vacuum breaker.
2. Operating Pressure Range: 20 to 80 psi (140 to 550 kPa).
3. Activation Pressure Drop: 3 psi (20 kPa).
4. Accessories:

a. Manufacturer's distribution unit with four outlet ports.

B. Electronic Trap Primer Systems (TP-2):

1. Description: ASSE 1044, packaged electronic trap primer system; factory piped and wired, with timer-controller, slow-acting solenoid, strainer, isolation valve, vacuum breaker, and distribution manifold.
2. Operating Pressure Range: 20 to 100 psi (140 to 690 kPa).
3. Minimum Outlet Ports on Distribution Manifold: Five outlet ports.
4. Controller Settings:

a. Discharge Frequency: Once every 24 hours.

b. Discharge Duration: 6 seconds.

c. Discharge Volume to Each Port: Minimum 2 ounces (60 mL) of water.

5. Cabinet:

a. Material: Galvanized steel.

b. Mounting: Recessed.

c. Cover: In same material as body of cabinet.

d. Provide cover with hinged, locking access door.

6. Electrical Characteristics:

a. Hardwired: 120 VAC at 60 Hz.

1) See Section 26 05 83 for electrical connections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Discard packing materials and verify product interiors are free from debris, damage, and corrosion.

B. Verify end connections, flanges, threads, and grooves are completely clean without signs of damage or degradation that could result in leakage.

C. For products containing isolation or shutoff valves, verify isolation and shutoff valves operate smoothly from fully closed to fully open.

3.2 INSTALLATION

A. Prior to installation of domestic water piping specialties, flush domestic water piping of foreign material.

B. Install products in accordance with manufacturer's instructions.

C. Install products level and plumb.

D. Install products with clearance for access and maintenance.

E. Support products NPS 2-1/2 (DN 65) and larger independently of surrounding pipe.

F. Support products with flanged or grooved ends independently of surrounding pipe.

G. For products containing isolation or shutoff valves, locate valves in horizontal piping with stems at or above center of piping, maintaining unimpeded stem movement.

H. Backflow Preventers:

1. Install backflow preventers in accordance with requirements of local authorities having jurisdiction, including requirements of local water utility.
2. Pipe relief from reduced-pressure-principle backflow preventers to nearest drain.

I. Water Pressure Reducing Valves:

J. Thermostatic Master Mixing Valves: Unless noted otherwise on drawings, install with centerline at 48 inches (1.2 m) above finish floor.

K. Balancing Valves: Install in accessible locations. Install shutoff valves on inlet and outlet.

L. Water Hammer Arrestors: Install in accordance with PDI-WH 201.

M. Trap Primers:

1. Install trap primers minimum of 12 inches (205 mm) above flood level of highest drain being served.
2. Unless noted otherwise on drawings, install electronic trap primer systems ~~with manifold centerline at 48 inches (1.2 m)~~ above finish ~~floor~~ceilings.

3. Check that water flows through piping and that there are no leaks before pouring slabs or closing in walls.
4. Cap unused ports on distribution manifold.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Inspect each product for damage and defects.

C. Repair or replace damaged products.

D. Replace defective products.

E. For products containing isolation or shutoff valves, exercise isolation and shutoff valves from fully closed to fully open. Confirm smooth operation.

F. Backflow Preventers:

1. Test in accordance with manufacturer's instructions.
2. Test in accordance with requirements of authorities having jurisdiction.
3. Test in accordance with ASSE listing of backflow preventer.
4. Replace backflow preventers that fail testing.

G. Vacuum Breakers:

1. Test in accordance with manufacturer's instructions.
2. Test in accordance with requirements of authorities having jurisdiction.
3. Test in accordance with ASSE listing of vacuum breaker.
4. Replace vacuum breakers that fail testing.

H. Water Pressure Reducing Valves: Confirm outlet pressure remains steady without fluctuation.

I. Mixing Valves: Confirm outlet temperature remains steady without fluctuation.

J. Electronic Trap Primer Systems:

1. Clean strainer.
2. Test system following manufacturer's instructions.
3. Visually confirm that water has reached each drain and that traps are full of water.
4. Operate system until each trap is full.

K. Coordination of Other Tests and Inspections: Provide access to accommodate tests and inspections by independent testing agencies employed by Owner.

3.4 ADJUSTING

A. Adjust pressure reducing valves to design pressure set point.

B. Adjust mixing valves to design temperature set point.

C. Adjust balancing valves to design flow.

D. Adjust electronic trap primers to design flow.

3.5 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Clean products to remove dirt, paint, and other foreign materials.

C. Clean surfaces of products exposed to view in finished spaces to remove dirt, fingerprints, paint, and other foreign materials. Restore finishes to match original factory finish.

D. Clean surfaces of products exposed to view on building exterior to remove dirt, fingerprints, paint, and other foreign materials. Restore finishes to match original factory finish.

E. Remove debris and clean interiors of equipment cabinets.

F. Clean strainers, including those internal to other products, prior to mm-dd-yyyy.

END OF SECTION 22 11 19

SECTION 22 11 23 - DOMESTIC WATER PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Circulators.

B. Inline pumps.

1.2 RELATED REQUIREMENTS

A. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.

B. Section 23 09 23 - Direct-Digital Control System for HVAC.

C. Section 26 05 83 - Wiring Connections.

1.3 REFERENCE STANDARDS

A. ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data:

1. Provide certified pump curve with duty point marked over pump and system operating conditions and NPSH curve and power requirement by pump tag.
2. Manufacturer's catalog sheets for fixtures, fittings, accessories, and supplies.

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.5 QUALITY ASSURANCE

A. Certifications: Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc, as suitable for purpose specified and indicated.

B. Identification: Provide pumps with manufacturer's name, model number, and rated capacity identified by permanently attached label.

C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 1-year manufacturer warranty for pumps except circulator type. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 CIRCULATORS

A. Manufacturers:

1. Bell & Gossett, a Brand of Xylem, Inc; _____: www.xylem.com/#sle.
2. Grundfos Pumps Corporation: www.grundfos.com/us/#sle.
3. Taco, Inc; _____: www.tacocomfort.com/#sle.

B. Casing: Bronze with bronze cast impeller, and stainless steel rotor assembly.

C. Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.

D. Mechanical Seal: Carbon rotating against a stationary ceramic seat.

E. Pipe-End Connection: Union connection.

F. Maximum Discharge Pressure: 145 psi (1000 kPa).

G. Motor: 1,750 rpm, ~~ECM duty~~ECM duty with flexible coupling.

H. Service Temperature Range: Minus 30 to 250 degrees F (Minus 34.4 to 121.1 degrees C).

I. Controls: Provide aquastat set for high-temp cutoff, electric plug, and illuminated hand switch.

2.2 INLINE PUMPS

A. Manufacturers:

1. Bell & Gossett, a Brand of Xylem, Inc; _____: www.xylem.com/#sle.
2. Grundfos Pumps Corporation: www.grundfos.com/us/#sle.
3. Taco, Inc; _____: www.tacocomfort.com/#sle.
4. _____.

B. Performance: As Scheduled on the Drawings.

1. Capacity: _____ gpm (_____ L/sec) flow at _____ feet (_____ kPa) of head.

C. Description: Split-coupled, end-suction pump for heads up to 175 psi (1206 kPa).

D. Type: Vertical, base-mount, single-stage inline with Class 125 flanged pipe-end connections.

E. Casing: Bronze with renewable bronze casing wearing rings and seal flush connection.

F. Impeller: Bronze, fully enclosed, keyed directly to solid alloy steel with bronze sleeve shaft.

G. Seal: Mechanical, single spring type, for 225 degrees F (107 degrees C) service.

H. Electrical:

1. Motor: 1,750 rpm, continuous duty; see Section 22 05 13.
2. Motor Protection: Include overvoltage, overcurrent, and motor overload.
3. Wiring Connections: See Section 26 05 83.
4. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products with related fittings, and accessories according to manufacturer instructions.

B. Potable and Drinking Water Service: Provide NSF 61 certified; comply with ICC (IPC).

C. Electrical-Driven Pump Work:

1. Provide electric-motor-driven equipment specified complete with local disconnect switch and control panel with starter, controls, safety devices, and related wiring.
2. Provide automatic control and protective devices field-wired to interface-related devices required for specified operation.

D. Ensure that small pressure gauges are installed on both upstream and downstream ends.

E. Hot Water Service: Ensure that small pressure-temperature gauges are installed on both upstream and downstream ends.

F. Cycle Duty Controlled Pumps: Set manually to ON for continuous operation.

G. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are nonoverloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Operational Tests: Upon completion and sterilization of plumbing systems, conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

END OF SECTION 22 11 23

SECTION 22 13 13 - FACILITY SANITARY SEWERS

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.

1.2 SUMMARY

A. This section covers work related to exterior sanitary sewer collection and conveyance systems shown on drawings and specifications.

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities procedures.
2. Division 32 Section "Turf and Grasses, Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
3. Division 31 Section "Earth Moving for Utilities" for soil materials, excavating, backfilling.
4. Division 31 Section "Dewatering" for requirements and guidelines for dewatering procedures.
5. Division 31 Section “Excavation Support and Protection" for requirements and guidelines for dewatering procedures.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)
2. ANSI A14.3 2008 Ladders-Fixed-Safety Requirements
3. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
4. ASTM C94 2009 Ready-Mixed Concrete
5. ASTM C443 2005 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
6. ASTM C478 2009 Precast Reinforced Concrete Manhole Sections
7. ASTM C700 2007 (Rev. A) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
8. ASTM C923 2008 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
9. ASTM C969 2002 Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
10. ASTM D2412 2002 (Rev. 2008) External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
11. ASTM D3034 2008 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
12. ASTM D3139 1998 (Rev. 2005) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

13. ASTM D3212 2007 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
14. ASTM D4101 2008 Polypropylene Plastic Injection and Extrusion Material
15. ASTM F405 2005 Corrugated Polyethylene (PE) Tubing and Fittings
16. ASTM F477 2008 Elastomeric Seals (Gaskets) for Joining Plastic Pipe
17. AMERICAN WATER WORKS ASSOCIATION (AWWA)
18. AWWA C104/A21.4 2008 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water (ANSI/AWWA C104/A21.4)
19. AWWA C110/A21.10 2008 Ductile-Iron and Gray-Iron Fittings
20. AWWA C111/A21.11 2006 Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
21. AWWA C153/A21.53 2006 Ductile-Iron Compact Fittings, 3 in. through 16 in., for Water and Other Liquids
22. AWWA C600 2005 Installation of Ductile-Iron Water Mains and Their Appurtenances
23. AWWA C900 2007 Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution
24. FEDERAL SPECIFICATIONS (FS)
25. FS RR-F-621 1998 (Rev. E) Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
26. UNI-BELL PLASTIC PIPE ASSOCIATION (UNI)
27. UNI B3 1992 Installation of Polyvinyl Chloride (PVC) Pressure Pipe
28. UNI B5 1989 Installation of Polyvinyl Chloride (PVC) Sewer Pipe
29. UNI B6 1990 Low-Pressure Air Testing of Installed Sewer Pipe

1.4 SUBMITTALS

A. Manufacturer's Catalog Data: Submit manufacturer's standard drawings or catalog cuts.

1. Fittings
2. Joints and couplings
3. Piping
4. Riser-wrap

B. Drawings

1. Precast concrete manholes
2. Metal work

1.5 PROJECT CONDITIONS

A. The General Contractor shall be responsible for all fees, permits and coordination with the local utility company related to the connection to the existing municipal sanitary sewer system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Piping: Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

B. Metal Items: Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

C. Cement, Aggregate, and Reinforcement: As specified in Section 03 30 00.

D. Handling: Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition.

PART 2 PRODUCTS

2.1 PIPELINE MATERIALS

A. PVC Plastic Gravity Sewer Piping

1. PVC Plastic Gravity Pipe and Fittings: ASTM D3034, SDR 35, with ends suitable for elastomeric gasket joints. The pipe shall be colored green to identify it for sewer applications.

B. Sewer Pipe Saddles: Provide pipe saddles in types as indicated on the Drawings. Strap-on sewer saddles are cast iron with a stainless steel saddle strap. Provide manufacturer's standard bolts, nuts, and mastic sealing compound with each saddle. Provide straps in sizes as required by pipe size.

C. Acceptable products/manufacturers are:

1. EJP, Inc.
2. Ipex Inc.
3. Hancor Pipe
4. ADS Pipe
5. North American Pipe
6. Approved equal.

D. Detection Materials: Provide detectable tape, or detection plates at all buried clean outs.

2.2 CONCRETE MATERIALS

A. Concrete materials shall be as specified in Section 03 30 00.

2.3 MISCELLANEOUS MATERIALS

A. Precast Concrete and Associated Materials

1. Precast Concrete Manhole Sections: Precast concrete manhole risers, base sections, and tops shall conform to ASTM C478. Base and first riser shall be monolithic. Standard is by American Concrete Co. and Superior Concrete Co.
2. Protective Coating: Plant-applied damp proofing is required for all exterior concrete surfaces for all sanitary structures.
3. Gaskets and Connectors: Gaskets for joints between manhole sections shall conform to ASTM C443. Standard is Kent-Seal. Resilient connectors for making joints between manhole and pipes entering manhole shall conform to ASTM C923.

B. Metal Items

1. Frames and Covers: Unless otherwise indicated on the drawings or specified, frames and covers shall be gray cast iron conforming to ASTM A 48/A 48M -03, Class 30B and suitable for AASHTO H 20-44 and HS 20-44 highway loading. Provide non-skid surface with raised letter "SEWER" designation cast on the cover. Acceptable products/manufacturers shall be:

    a. General Foundries Item Number 12681 (25.75” diameter cover with 8” deep frame) or approved equal;

    b. Or as otherwise specified on drawings.

2. Manhole Steps: Zinc-coated steel conforming to ANSI A14.3. As an option, plastic or rubber coating pressure-molded to the steel may be used. Plastic coating shall conform to ASTM D4101, copolymer polypropylene. Rubber shall conform to ASTM C443, except shore A durometer hardness shall be 70 plus or minus 5. Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 4 feet deep.

C. Riser-wrap

1. Riser-Wrap is supplied in bulk rolls along with Polyken #1027 liquid adhesive (furnished in 1-gallon cans) and 6” wide joiner- strips.
2. All Riser-Wrap coating material shall be stored, handled, and transported in such a manner as to prevent damage to individual carton or containers. Cartons, sleeve rolls, joiner-strips or individual repair sleeves removed from the storage pallets shall not be dropped, rolled, or thrown in any manner as to damage the coating material. Cartons or sleeve rolls shall not be handled with hooks, ropes, cables, or any other mechanical devices as to damage the coating materials.
3. Factory rolls and/or cartons shall be stacked on end at all times and no higher than seventy-two (72) inches.
4. The coating material shall be stored and/or transported in a dry, ventilated location. Storage temperature shall be a minimum of 4 °F and not to exceed 130 °F.
5. Individual cartons or rolls of coating material shall not contact bare ground or bare warehouse floor. Tools or equipment shall not be stacked on top of the rolls.
6. Riser-Wrap materials that have been damaged or show signs of deterioration shall be inspected by representatives of the owner and at the discretion of the end-user may be rejected.
7. Riser-Wrap sleeves are supplied with a plastic release liner on the adhesive side. This release liner is required to prevent the highly aggressive adhesive from prematurely bonding to itself and protect the adhesive surface from contamination. It should not be removed until time of application.
8. Polyken #1027 liquid adhesive shall be stored in accordance with regulations that govern hazardous material storage. Primer inventory shall rotate on a first in - first out basis. Primer containers shall be marked with receiving date.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

A. General Requirements for Installation of Pipeline: Apply except where specific exception is made in the following paragraphs entitled, "Special Requirements."

1. Location: The work covered by this section shall terminate at a point approximately 10 feet from the building, unless otherwise indicated. Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 10 feet to a water main or service line. Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 10 feet on each side of the crossing, or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance. Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 3 feet, horizontal distance, to the water line.
2. Earthwork: Perform earthwork operations in accordance with Section 31 21 00.
3. Pipe Laying and Jointing: Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Adjust spigots in bells to give a uniform space all around. Blocking or wedging between bells and spigots will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose.

    a. Lay nonpressure pipe with the bell ends in the upgrade direction.

    b. Lay pressure pipe with the bell ends in the downgrade direction, or in other words the pressurized flow should hit the bell end of the pipe first.

4. Connections to Existing Lines: Obtain approval from the Architect before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line. Obtain and pay for any permits needed to connect to existing lines. Contact the local utility company two days before making connection to existing lines. Follow regulations of local utility company related to connecting to their lines. Regrade and repair areas as needed to restore surfaces to existing features.

B. Special Requirements

1. Installation of PVC Plastic Piping: Install pipe and fittings in accordance with paragraph entitled, "General Requirements for Installation of Pipelines" of this section and with the requirements of UNI B5 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of UNI B5 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

2. Cleanouts: Construct cleanouts of PVC sanitary pipe and fittings with cleanout cover.

C. Concrete Work: Cast-in-place concrete is included in Section 03 30 00.

D. Manhole Construction: Use precast concrete base sections. Make inverts in precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

E. Riser-Wrap/Joint Sealing Installation

1. The exterior of the manhole or vault shall be brushed by broom or hand wire tools to remove any loose cement dust or small rock particles from the surface. Sharp edges or points should be also removed or flattened.
2. Preheating is only necessary below when ambient temperatures are below 60 °F and/or moisture is apparent on the surface. The function of preheating is primarily to remove excess moisture and warm the surface where Riser-Wrap is to be installed. In many cases, preheating may not be required.
3. Visible oil and/or grease shall be removed by use of a suitable solvent. Kerosene shall not be used for solvent cleaning.
4. Cleaned surfaces of manhole sections shall not be allowed to sit for extended periods under wet or humid conditions prior to the application of the Riser-Wrap system.
5. Dust and/or other loose materials shall be removed prior to application of primer by dry air blow or broom brushing.
6. The joint sealing system shall always be applied on top of the Polyken #1027 or #1039 liquid adhesive primers.
7. The primer shall be thoroughly mixed prior to application. The primer is applied to the concrete surface with a brush or paint roller to a wet thickness of no less than two (2) mils and no greater than five (5) mils. Primer container shall remain covered when not in use.
8. The primer shall cover the entire exposed concrete surface and manhole cover frame including the indentations caused by the irregular concrete surface where the Riser-Wrap material is to be installed.
9. The primer shall be "dry to touch” prior to the application of the Riser-Wrap. Under no circumstances shall the sleeve be applied over a wet primer surface.
10. The primer shall not be diluted. Primer cans shall remain covered when not in use, to avoid solvent evaporation or contamination and shall be disposed of properly.

11. For street surface enclosures allow approximately 5” of sleeve material to extend upward above the manhole cast iron ring (manhole cover frame). This excess material will fold down over the ring during application. Note that concrete manhole cones have changing circumferences. Always measure the sleeve twice prior to cutting from the longest (largest circumference) place where sleeve is to be installed.
12. Remove 8” of liner from back of sleeve and attach the edge vertically to the manhole section. Hold edge in place and begin to unroll sleeve along marked line; removing liner as you move around the manhole cone section until you have overlapped the starting edge.
13. Using a small amount of flame, heat the adhesive side of the joiner-strip (white textured side) and place the 6” wide joiner-strip vertically across the overlapped sleeve edges (black side out). Hold in-place and apply a small amount of heat to the joiner-strip while gently patting it down with a gloved hand. Adjust torch to medium-high output and begin heating the sleeve (minimum of 6” from joiner-strip) along the bottom edge of Riser-Wrap, moving in one direction and keeping the torch moving in a continuous up and down motion. Continue heating sleeve towards top edge, watching the sleeve closely, so adhesives edges do not touch.
14. Use roller to move adhesive towards outer sleeve edges and to remove wrinkles or bubbles. Do not cut sleeve to remove wrinkles.
15. The Riser-Wrap embossed sleeve outer surface informs the applicator that the sleeve is thoroughly heated when the embossment disappears and also when the adhesive is showing on the outer edges. This is a permanent indicator and provides the inspector information that the heating process has been completed.
16. Do not cut the Riser-Wrap sleeve while applying over cast iron manhole gussets. Gently fold the heated sleeve around them. Cuts can be made later after the Riser-Wrap has cooled to ambient temperature if desired.
17. For complete encapsulation application-begin installation at lowest point, applying sleeves upward in layers that overlap the previous sleeve by 2”. Also, the vertical placement of the joiner-strips on each successive wrap should be horizontally staggered to avoid vertical stacking.
18. Filler cord material may be required for step-downs exceeding 1” in variation and/or to repair damaged concrete areas or cover sharp protrusions that cannot be removed by other means.

F. Miscellaneous Construction and Installation

1. Metal Work: Workmanship and Finish: Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

3.2 FIELD QUALITY CONTROL (NOTE: ALSO PERFORM ALL TESTING REQUIRED BY THE LOCAL UTILITY COMPANY)

A. Field Tests and Inspections: The Architect or representative will conduct field inspections and witness field tests specified in this section.

B. Leakage Tests: Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

C. Low-pressure Air Tests: Perform tests as follows:

1. The contractor shall test the gravity sewer with a low-pressure air test. After completing backfill of a section of wastewater line, the contractor shall at his own expense, conduct a Line Acceptance Test using low pressure air.

a. The portion of line being tested shall be termed “Acceptable” if the time required in minutes for the pressure to decrease as stated below (greater than the average back pressure of any ground water that may be over the pipe) shall not be less than the time shown for the given diameters in the following table:

b. PVC Plastic Pipelines: Test all new lines at 4 psi with an allowable pressure drop of one (1) psi at the following durations for a specific pipe diameter size:

1) 15” diameter – 17 minutes

2) 12” diameter – 11.5 minutes

3) 10” diameter – 8 minutes

4) 8” diameter – 5 minutes

5) 6” diameter – 4 minutes

6) 4” diameter – 4 minutes

D. Internal pressure tests for force mains:

1. All force mains shall be tested per the testing requirements:

a. conduct all pressure and leakage testing in accordance with AWWA standards

b. Decrease pressure in the main to be tested approximately 20 psi. Observe test gauge to ensure the pressure doesn’t rise due to an existing valve or tapping valve leaking by. This is done to ensure that no undisinfected water from the installed main enters the existing main while performing the actual test

c. A pressure test pump shall be connected to the new main at the testing point. The pressure will be slowly increased to 150 psig and allowed to stabilize (+/- 2.5 psig) for a minimum of 15 minutes.

d. A reservoir of potable water shall be connected to the test pump and the initial level of water recorded.

e. The pump pressure shall be maintained at 150 psig for a minimum of 1 hour with all makeup water withdrawn from the reservoir.

f. After one hour, the water level in the reservoir will be measured and the volume of water drawn down from the reservoir calculated and compared with the following allowable leakage:

1) Allowable leakage (ounces per hour) – (pipe length (feet) X Nominal Diameter (inches) x128)/10,900

g. If any test discloses leakage greater than that specified above, the contractor, at his own expense, shall locate the leak and make repairs as necessary until the leakage is within the specified allowance. Written certification of leakage and pressure testing shall be submitted to the engineer upon completion.

E. Deflection Testing: Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection-measuring device.

1. Pull-through Device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections shall conform to the following:

a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

b. Homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees F, and shall have a surface Brinell hardness of not less than 150.

c. Center bored and through-bolted with a 1/4-inch minimum diameter steel shaft having a yield strength of not less than 70,000 pounds per square inch, with eyes or loops at each end for attaching pulling cables.

d. Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

2. Deflection Measuring Device: Sensitive to 1.0 percent of the diameter of the pipe being tested and shall be accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved prior to use.
3. Pull-through Device Procedure: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.
4. Deflection Measuring Device Procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe, which has excessive deflection, and completely retest in same manner and under same conditions.

F. Tests for Manholes

1. Vacuum Test: The manhole being tested must not be backfilled. The test is passing if the manhole holds 10 inches of mercury vacuum for 3 minutes with one inch of mercury allowable loss. Contractor shall perform field tests and provide labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

G. Field Tests for Concrete: Field testing requirements are covered in Section 03 30 00.

END OF SECTION 22 13 13

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Floor drains.

B. Floor sinks.

C. Cleanouts.

1.2 RELATED REQUIREMENTS

A. Section 22 10 05 - Plumbing Piping.

B. Section 22 11 19 - Domestic Water Piping Specialties: Trap primers.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's literature and data sheets for each product. Include information on fabrication materials, assembly of components, dimensions, ratings, finishes, rough-in requirements, and installed accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

C. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

D. Store products under cover and protected from weather and dirt. Elevate above grade.

E. Store plastic products protected from direct sunlight.

PART 2 PRODUCTS

2.1 FLOOR DRAINS

A. Cast Iron Floor Drains:

1. Manufacturers:

   a. MIFAB, Inc: www.mifab.com/#sle.

   b. Zurn Water, LLC: www.zurn.com/#sle.

2. Assembly: ASME A112.6.3.
3. Body: Lacquered cast iron with anchor flange and membrane clamping collar with weepholes.
4. Strainer: Adjustable, removable, with vandal-proof screws.

a. Round:

1) Material: Nickel bronze.

2) Diameter: 6 inches (152 mm).

b. Square:

1) Material: Nickel bronze.

2) Size: 6 by 6 inches (152 by 152 mm).

c. Round with Funnel:

1) Material: Nickel bronze.

2) Strainer Diameter: 7 inches (178 mm).

3) Funnel: Round, 4-inch diameter (102 mm diameter).

5. Accessories:

a. Trap primer plug.

2.2 FLOOR SINKS

A. Cast Iron Floor Sinks:

1. Manufacturers:

a. MIFAB, Inc: www.mifab.com/#sle.

b. Zurn Water, LLC: www.zurn.com/#sle.

c. _____.

2. Assembly: ASME A112.6.7.
3. Body: Cast iron with white acid-resistant enameled interior and interior anti-splash dome strainer.

a. Square:

1) Size: 8 by 8 inches (203 by 203 mm).

2) Sump Depth: 6 inches (152 mm).

4. Clamping Flange: Provide anchor flange with membrane clamping collar.
5. Grate: Loose set.

a. Material: White acid-resistant enameled cast iron.

b. Style: Half grate.

6. Accessories:

a. Trap primer plug.

2.3 CLEANOUTS

A. Manufacturers:

1. MIFAB, Inc: www.mifab.com/#sle.
2. Zurn Water, LLC: www.zurn.com/#sle.
3. _____.

B. Floor Cleanouts:

1. Assembly: ASME A112.36.2.
2. Body: Lacquered cast iron.
3. Closure Plug: PVC or ABS, threaded, gastight and watertight.
4. Top: Adjustable, with vandal-proof screws.

a. Shape and Finish:

1) All Locations, Unless Noted Otherwise: Round; nickel bronze.

2) Carpet: Round; cover recessed for carpet inlay.

3) Concrete, Finished and Unfinished: Round; nickel bronze.

4) Tile: Square; cover recessed for tile insert.

5) Vinyl Flooring: Round; cover recessed for vinyl insert.

C. Wall Cleanouts:

1. Assembly: ASME A112.36.2.
2. Body: Tee type; body material to match surrounding pipe.
3. Plug: PVC or ABS, threaded, gastight.
4. Access Cover: Round, stainless steel wall access cover with vandal-proof screw.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify conditions are satisfactory for installation prior to starting work.

B. Verify floor sink locations are coordinated with latest published kitchen equipment plans and plumbing plans.

3.2 INSTALLATION

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

B. Maintain continuity of waterproofing membranes. Secure waterproofing membranes to drain clamping collars and bonding flanges.

C. Install drains so strainers and grates are level and are at design elevation.

D. Install floor sinks so grates are flush with finished floor unless noted otherwise or unless directed otherwise by adopted code.

E. Extend cleanouts to finished floor or wall surface. Ensure clearance at cleanout for rodding or jetting of drainage system.

F. Install floor cleanouts to allow for floor finishes.

G. Locate, provide, and install cleanouts in piping in accordance with adopted code.

3.3 PROTECTION

A. Protect installed drains from accumulating dirt and debris through remainder of construction.

B. Protect installed products from damage due to subsequent construction operations.

END OF SECTION 22 13 19

SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Commercial indirect-fired water heaters.

B. Commercial electric water heaters.

C. Diaphragm-type compression tanks.

1.2 RELATED REQUIREMENTS

A. Section 22 11 23 - Domestic Water Pumps.

1.3 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .

C. AWWA C652 - Disinfection of Water-Storage Facilities; 2019.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data:

1. Product Data: Provide manufacturer's literature and data sheets for each product. Include information on materials of fabrication, assembly of components, dimensions, weights, capabilities, performance, electrical characteristics, location and sizes of connections, service and access locations, and manufacturer-provided and field-installed accessories.

C. Shop Drawings:

1. Provide plans and elevations showing equipment assembly, including fabrication and installation details. Show location and sizes of connections.

a. Include arrangements of adjacent piping and valves.

2. Indicate clearances required for service, access, maintenance, and replacement of internal components.

D. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.6 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 5-year manufacturer warranty for _____. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 WATER HEATERS

A. Manufacturers:

1. A.O. Smith Corporation: www.hotwater.com/#sle.
2. Bradford White Corporation; _____: www.bradfordwhite.com/#sle.
3. Heat Transfer Products (HTP)
4. Rheem Manufacturing Company; _____: www.rheem.com/#sle.

B. Commercial Indirect-Fired Water Heaters:

1. Type: Automatic, indirect-fired, vertical storage.
2. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
3. Tank: ~~Glass lined~~ ___ welded steel ASME labeled; ~~multiple flue passages~~stainless steel tube bundle heat exchanger, 4 inch (100 mm) diameter inspection port, thermally insulated with minimum 2 inches (50 mm) ~~glass fiber~~polyurethanefoam, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
4. Accessories:
   a. Water Connections: ~~Brass~~Stainless steel.
   b. Dip Tube: ~~Brass~~Stainless steel.
   c. Drain valve.
   d. Anode: ~~Magnesium~~Not required for stainless steel construction..
   e. Temperature and Pressure Relief Valve: ASME labeled.
5. Applications:
   a. Automatic storage water heater.

C. Commercial Electric Water Heaters:

1. Manufacturers:
   a. Bradford White Corporation; ElectriFLEX Series: www.bradfordwhite.com/#sle.
   b. _____.
   c. _____.

2. Type: Factory-assembled and wired, electric, vertical storage.
3. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
4. Performance: As scheduled on the Drawings.
5. Electrical Characteristics:
6. Tank: ~~Glass lined welded steel~~Blow molded polybutene; ~~4 inch (100 mm) diameter inspection port~~, thermally insulated with minimum 2 inches (50 mm) ~~glass fiber~~polyurethanefoam encased in corrosion-resistant steel jacket; baked-on enamel finish.
7. Heat Pump Circuit: Factory-charged refrigerant heat pump circuit including scroll compressor, expansion valve, evaporator coil and fan, and condenser coil molded around storage tank.
    a. Filter: Removable, washable evaporator coil filter.
    b. Ambient operation range: 35 to 120 deg F.
    c. Optional ducting kit.
8. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F (16 to 82 degrees C), flanged or screw-in nichrome elements, high temperature limit thermostat.
9. Accessories:
    a. Water Connections: Brass.
    b. Dip Tube: Brass.
    c. Drain valve.
    d. Anode: Magnesium.
    e. Temperature and Pressure Relief Valve: ASME labeled.
10. Heating Elements: SCrew-in or bolt-in~~Flange-mounted~~ immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in (11.6 W/sq m).

2.2 DIAPHRAGM-TYPE COMPRESSION TANKS

A. Manufacturers:

1. Amtrol Inc; _____: www.amtrol.com/#sle.
2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
3. _____.

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi (83 kPa).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions required for applicable certifications.

B. Electrical Work: Provide automatic control and protective devices with associated wiring to interconnect related interfaced devices required for specified operation.

C. Coordinate system, equipment, and piping work with applicable electrical, fuel, gas, vent, drain, and waste support interconnections as included or provided by other trades.

D. Domestic Hot Water Storage Tanks:

1. Provide steel pipe support, independent of building structural framing members.
2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

3.2 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Clean interior of water tanks and disinfect in accordance with AWWA C652.

END OF SECTION 22 30 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Water closets.
2. Lavatories.
3. Sinks.
4. Service basins.
5. Electric water coolers.
6. Emergency fixtures.
7. Protective shielding guards.
8. Fixture supports.

B. Related Sections include the following:

1. Section 019113 “General Commissioning Requirements”
2. Division 6 Section “Interior Architectural Woodwork” for solid surface fixtures and casework.
3. Division 10 Section "Toilet, Bath, and Laundry Accessories."
   ~~Division 11 Section “Laboratory Casework” for solid surface fixtures and casework.~~
4. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, trench drains, and specialty fixtures.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing that can be approached, entered, and used by people with disabilities.

C. 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, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

E. PVC: Polyvinyl chloride plastic.

1.4 REFERENCE STANDARDS

A. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).

B. ASME A112.6.3 - Floor Drains; 2022.

C. ASME A112.18.1 - Plumbing Supply Fittings; 2024.

D. ASME A112.18.2 - Plumbing Waste Fittings; 2020 (Reaffirmed 2025).

E. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.

F. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

G. ASME B1.20.7 - Hose Coupling Screw Threads (Inch); 1991 (Reaffirmed 2024).

H. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers; 2021.

I. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2023.

J. ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers; 2020.

K. ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations; 2017 (Reaffirmed 2021).

L. ASTM F446 - Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area; 2019 (Reapproved 2023).

M. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

O. NSF 2 - Food Equipment; 2025.

P. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

Q. UL 1951 - Standard for Safety Electric Plumbing Accessories; Current Edition, Including All Revisions.

1.5 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.

1.6 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. 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.

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. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Plastic Mop-Service Basins: ANSI Z124.6.
2. Plastic Shower Enclosures: ANSI Z124.2.
3. Slip-Resistant Bathing Surfaces: ASTM F 462.
4. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
5. Vitreous-China Fixtures: ASME A112.19.2M.
6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
4. Faucets: ASME A112.18.1.
5. Hand-Held Showers: ASSE 1014.
6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
7. Hose-Coupling Threads: ASME B1.20.7.
8. Manual-Control Antiscald Faucets: ASTM F 444.
9. Pipe Threads: ASME B1.20.1.
10. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. 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. Manual-Operation Flushometers: ASSE 1037.
5. Brass Waste Fittings: ASME A112.18.2.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Dishwasher Air-Gap Fittings: ASSE 1021.
2. Floor Drains: ASME A112.6.3.
3. Grab Bars: ASTM F446.
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.

1.7 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components 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: One year(s) from date of Substantial Completion.

1.8 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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
4. Water-Closet flush valve, repair kits: Equal to 5 percent of amount of each type installed.
5. Toilet Seats: Equal to 5 percent of amount of each type installed.
6. Inline Water Filter Housing Filters: Provide 4 replacement filters for each filter housing installed.
7. Water Cooler Filters: Provide a box of 20 replacement filters for each water cooler provided.

PART 2 PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

a. Vitreous China Fixtures:

1) American Standard.

2) Eljer.

3) Kohler.

b. Toilet Seats:

1) Bemis Manufacturing Company.

2) Church Seats.

3) Olsonite Corp.

c. Fixture Supports:

1) Josam Company.

2) Mifab Manufacturing Inc.

3) Smith, Jay R. Mfg. Co.

4) Tyler Pipe, Wade Div.

5) Watts Drainage Products Inc.

6) Zurn Plumbing Products Group.

d. Stainless Steel Sinks:

1) Advance Tabco.

2) Arkay.

3) Elkay.

4) Just.

e. Flush Valves:

1) American Standard.

2) Sloan.

3) Zurn.

f. Faucets:

1) American Standard.

2) Chicago Faucets.

3) T & S Brass and Bronze Works, Inc.

g. Emergency Fixtures:

1) Bradley

2) Guardian

3) Speakman

~~Shower valves and Controls:~~

~~Bradley~~

~~Leonard.~~

~~Powers.~~

~~Symmons.~~

h. Electric Water Coolers:

1) Halsey Taylor.

2) Elkay.

3) Sloan.

2.2 FIXTURE SCHEDULE

A. WC-1 ADA Water Closet:

1. ADA ~~Wall hung~~floor mounted tank-type vitreous china ~~withconcealed carrier, vitreous china,~~ 1.28 gpf high efficiency siphon jet action, elongated rim~~, top spud~~, water closet

~~with exposed, sensor activated, hardwired, chrome plated, brass flushometer valve with mechanical manual override~~.

a. Basis of Design: American Standard ~~3351.101~~211AA.104

b. Flush~~ometer Basis of Design: Sloan Regal 111 SFSM-1.28-HW~~ lever must be on access side of fixture.

~~Provide transformer kit EL-451 for powering up to 6 flush valves.~~

c. Open front seat less cover: Equal to Church 295CT-047.

d. Mount rim 1~~7~~6.5" above finished floor.

e. Fixture and seat shall be white.

f. Trim and fittings shall be chrome plated finish.

~~Floor mounted concealed chair carrier.~~

~~WC-2 Water Closet:~~

~~Wall hung with concealed carrier, vitreous china, 1.28 gpf high efficiency siphon jet action, elongated rim, top spud, water closet with exposed, sensor activated, hardwired, chrome plated, brass flushometer valve with mechanical manual override.~~

~~Basis of Design: American Standard 3351.101.~~

~~Flushometer Basis of Design: Sloan Regal 111 SFSM-1.28-HW~~

~~Provide transformer kit EL-451 for powering up to 6 flush valves.~~

~~Open front seat less cover: Equal to Church 295CT-047.~~

~~Mount rim 15" above finished floor.~~

~~Fixture and seat shall be white.~~

~~Trim and fittings shall be chrome plated finish.~~

~~Floor mounted concealed chair carrier.~~

B. LAV-1 ADA Wall Hung Lavatory:

1. Wall hung, ~~stainless steel~~vitreous china, ~~barrier free~~ADA lavatory with rear center drain, ~~8"~~single faucet hole~~s~~, and concealed wall ~~bracket~~carrier. Faucet shall be ~~cast brass construction with fixed/swivel gooseneck, ceramic cartridges with wrist blade handles, and 1.0 GPM max. flow spray outlet~~deck mounted cast brass, single-hole, single mixing lever with ceramic cartridge, and 1.0 GPM max. flow restrictor.

a. Lavatory: Equal to A~~dvance Tabco 7-PS-75~~merican Standard Decorum 9024.901EC.

b. Faucet: Equal to American Standard ~~Monterrey 6540.160~~Aspirations 7061.101.

c. Offset 17 Gauge Grid Strainer Assembly: Equal to McGuire 155WC series.

d. Trap: 17 gauge chrome plated brass.

e. Concealed arm carrier support.

f. Fixture shall be white.

g. Faucet, drain, trim, and fittings shall be chrome plated finish.

h. Chrome plated supply tubing kit with quarter turn stops.

i. Provide protective shielding guards on exposed piping.

~~LAV-2 ADA Lavatory Deck with 2-Integral Bowls:~~

~~Solid surface lavatory deck with integral sink bowls by Division 12.~~
~~Faucet for each bowl, shall be deck mounted cast brass, single-hole, single mixing lever with ceramic cartridge, and 1.0 GPM max. flow restrictor.~~

~~Faucet: American Standard Aspirations 7061101.~~

~~17 Gauge Grid Strainer Assembly: Equal to McGuire 155A series.~~

~~Chrome plated supply tubing kit with chrome plated quarter turn stops.~~

~~Faucet, drain, trim, and fittings shall be chrome plated finish.~~

~~Provide protective shielding guards on exposed piping.~~

~~ADA Compliant.~~

~~SK-1 Double Bowl Sink:~~

~~Floor standing utility sink with two 24" x 24" x 14" deep bowls, 14 gauge 304 stainless steel sink with 24" drainboard on the right, 12" high backsplash, 8" faucet center punching above each partition, and center drains. Four 1-5/8" diameter stainless steel legs with adjustable feet.~~
~~Drain assembly shall have 90° valve outlet with lever handle and support arm at front of fixture.~~
~~Backsplash mounted faucet with 8" centers, pre-rinse riser with hose and 1.0 gpm spray valve, 9" swivel spout with 2.2 GPM aerator, and ceramic cartridges with wrist blade handles.~~

~~Sink: Equal to Advance Tabco FC-2-2424-24R.~~

~~Faucet: Equal to Chicago Faucets 523-613-317ABCP.~~

~~Provide with strainer drain and valve assembly equal to Advance Tabco K-5 with support bracket K-4.~~

~~Chrome plated supply tubing kit with quarter turn stops.~~

~~Faucet, drain, trim, and fittings shall be chrome plated finish.~~

C. SK-~~2~~1 ADA Single Bowl Sink:

1. Countertop provided by Div 10. Coordinate dimensions of holes required for bowl and faucet.
2. Drop-in, 18 gauge stainless steel ADA sink with single ~~28~~16" x ~~16~~13-1/2" x ~~6~~5-1/2" deep bowl, ledge, and rear center drains. Faucet shall have ~~8~~4" centers, gooseneck spout, 1.5 GPM aerator, and ceramic cartridges with wrist blade handles.
    a. Sink: Equal to ~~Just Manufacturing Company~~ Elkay~~UDADA2233A60~~ JLRAD191955.
    b. Faucet: Equal to ~~Chicago Faucets 786-GN8AE3XKABCP~~American Standard Monterrey 7500.170.
    c. Provide with strainer drain assembly equal to McGuire 151.
    d. Provide 17 gauge offset drain and trap assembly.
    e. Faucet, drain, trim, and fittings shall be chrome plated finish.
    f. Chrome plated supply tubing kit with quarter turn stops.
    g. ADA Compliant.

D. SK-~~3~~2ADADouble Bowl Sink:

1. ~~Floor standing utility sink with two 30" x 30" x 14" deep bowls, 14 gauge 304 stainless steel sink with dual 30" drainboards, 12" high backsplash, 8" faucet center punching above each partition, and center drains. Four 1-5/8" diameter stainless steel legs with adjustable feet~~Countertop provided by Div 10. Coordinate dimensions of holes required for bowl and faucet.
2. ~~Drain assembly shall have 90° valve outlet with lever handle and support arm at front of fixture~~Drop-in, 18 gauge stainless steel ADA sink with two 14" x 14" x 5-1/2" deep bowls, ledge, and rear center drains. Faucet shall have 8" centers, gooseneck spout, 1.5 GPM aerator, and ceramic cartridges with wrist blade handle.
3. ~~Backsplash mounted faucet with 8" centers, pre-rinse riser with hose and 1.0 gpm spray valve, 9" swivel spout with 2.2 GPM aerator, and ceramic cartridges with wrist blade handles.~~
    a. Sink: Equal to ~~Advance Tabco FC-2-3030-30RL~~Elkay LRAD331955.
    b. Faucet: Equal to ~~Chicago Faucets 523-613-317ABCP.~~ American Standard Monterrey 6409.170.
    c. ~~Provide with strainer drain and valve assembly equal to Advance Tabco K-5 with support bracket K-4.~~Provide with strainer drain assembly equal to McGuire 151.
    d. Provide 17 gauge offset drain and trap assembly.
    e. Chrome plated supply tubing kit with quarter turn stops.
    f. Faucet, drain, trim, and fittings shall be chrome plated finish.
    g. ADA Compliant.

~~SK-4 Double Bowl Sink:~~

Floor standing utility sink with one 48" x 24" x 14" deep bowl, 14 gauge 304 stainless steel sink with dual 24" drainboards, 12" high backsplash, 8" faucet center punching above each partition, and center drains. Four 1-5/8" diameter stainless steel legs with adjustable feet.
Drain assembly shall have 90° valve outlet with lever handle and support arm at front of fixture.
Backsplash mounted gooseneck faucet with 8" centers, 10" swivel spout with 1.5 GPM aerator, and ceramic cartridges with wrist blade handles.

Sink: Equal to Advance Tabco FC-2-2424-24RL.

Faucet: Equal to Chicago Faucets 631-GN10AE35SWGAB.

Provide with strainer drain and valve assembly equal to Advance Tabco K-5 with support bracket K-4.

Chrome plated supply tubing kit with quarter turn stops.

Faucet, drain, trim, and fittings shall be chrome plated finish.

SK-5 ADA Single Bowl Sink:

Single bowl film sink with 72" x 30" x 6" deep bowl, 20 gauge 304 stainless steel sink with flanged perimeter and rear drain.
Support Frame: Steel stand to support sink pan at ADA height with powdercoated black finish and integral shelf.
Inlet Station: Wall mounted mixing valve with inlet ball valves, check valves, discharge ball valve and dial thermometer connected to 10" clear cartridge filter housing, 20 micron filter media, and integral pressure relief.
Two wall mounted valves with wrist blade handles separately piped to wall mounted 90° serrated outlets.

Sink: Equal to Arkay.

Valves: Equal to Chicago Faucets 769-317COLDABCP.

Outlets: Equal to Chicago Faucets LRS-C01.

Frame: Equal to Arkay.

Mixing Valve: Equal to Leonard TM-26-LF.

Filter Housing: Pentair Standard 10" housing (#150435) and Pentair S1 10" filter (#155001-43).

Provide with strainer drain and basket assembly equal to Advance Tabco K-6.

Chrome plated supply tubing kit with quarter turn stops.

Faucet, drain, trim, and fittings shall be chrome plated finish.

Provide spare filters as noted in Part 1 'Extra Materials' section.

SK-6 Double Bowl Sink:

Floor standing utility sink with one 48" x 24" x 14" deep bowl, 14 gauge 304 stainless steel sink with dual 24" drainboards, 12" high backsplash, 8" faucet center punching above each partition, and center drains. Four 1-5/8" diameter stainless steel legs with adjustable feet.
Drain assembly shall have 90° valve outlet with lever handle and support arm at front of fixture.
Backsplash mounted gooseneck faucet with 8" centers, 10" swivel spout with 1.5 GPM aerator, and ceramic cartridges with wrist blade handles.
Inlet Station: Wall mounted mixing valve with inlet ball valves, check valves, discharge ball valve and dial thermometer connected to 10" clear cartridge filter housing, 20 micron filter media, and integral pressure relief. Outlet piped to hose outlet.
Hose Outlet: Back splash mounted with 90° valve with lever handle. Hose thread outlet with integral vacuum breaker.

Sink: Equal to Advance Tabco FC-2-2424-24RL.

Faucet: Equal to Chicago Faucets 631-GN10AE35SWGAB.

Hose Outlet: Equal to Chicago Faucets 387-E27-369COLDCP.

Mixing Valve: Equal to Leonard TM-26-LF.

Filter Housing: Pentair Standard 10" housing (#150435) and Pentair S1 10" filter (#155001-43).

Provide with strainer drain and valve assembly equal to Advance Tabco K-5 with support bracket K-4.

Chrome plated supply tubing kit with quarter turn stops.

Faucet, drain, trim, and fittings shall be chrome plated finish.

SK-7 ADA Single Bowl Sink:

Single bowl film sink with 96" x 30" x 6" deep bowl, 20 gauge 304 stainless steel sink with flanged perimeter and rear drain.
Support Frame: Steel stand to support sink pan at ADA height with powdercoated black finish and integral shelf.
Inlet Station: Wall mounted mixing valve with inlet ball valves, check valves, discharge ball valve and dial thermometer connected to 10" clear cartridge filter housing, 20 micron filter media, and integral pressure relief.
Two wall mounted valves with wrist blade handles separately piped to wall mounted 90° serrated outlets.

Sink: Equal to Arkay.

Valves: Equal to Chicago Faucets 769-317COLDABCP.

Outlets: Equal to Chicago Faucets LRS-C01.

Frame: Equal to Arkay.

Mixing Valve: Equal to Leonard TM-26-LF.

Filter Housing: Pentair Standard 10" housing (#150435) and Pentair S1 10" filter (#155001-43).

Provide with strainer drain and basket assembly equal to Advance Tabco K-6.

Chrome plated supply tubing kit with quarter turn stops.

Faucet, drain, trim, and fittings shall be chrome plated finish.

Provide spare filters as noted in Part 1 'Extra Materials' section.

SK-8 ADA Single Bowl Sink:

Single bowl film sink with 60" x 30" x 6" deep bowl, 20 gauge 304 stainless steel sink with flanged perimeter and rear drain.
Support Frame: Steel stand to support sink pan at ADA height with powdercoated black finish and integral shelf.
Inlet Station: Wall mounted mixing valve with inlet ball valves, check valves, discharge ball valve and dial thermometer connected to 10" clear cartridge filter housing, 20 micron filter media, and integral pressure relief.
Two wall mounted valves with wrist blade handles separately piped to wall mounted 90° serrated outlets.

Sink: Equal to Arkay.

Valves: Equal to Chicago Faucets 769-317COLDABCP.

Outlets: Equal to Chicago Faucets LRS-C01.

Frame: Equal to Arkay.

Mixing Valve: Equal to Leonard TM-26-LF.

Filter Housing: Pentair Standard 10" housing (#150435) and Pentair S1 10" filter (#155001-43).

Provide with strainer drain and basket assembly equal to Advance Tabco K-6.

Chrome plated supply tubing kit with quarter turn stops.

Faucet, drain, trim, and fittings shall be chrome plated finish.

Provide spare filters as noted in Part 1 'Extra Materials' section.

SK-9 ADA Double Bowl Sink:

Countertop provided by Div 10. Coordinate dimensions of holes required for bowl and faucet.
Drop-in, 18 gauge stainless steel sink with two 14" x 14" x 6-1/2" deep bowls, ledge, and rear center drains. Faucet shall have 8" centers, gooseneck spout, 1.5 GPM aerator, and ceramic cartridges with wrist blade handles.

Sink: Equal to Just Manufacturing Company DLADA1933A65-J.

Faucet: Equal to Chicago Faucets 786-GN8AE3XKABCP.

~~Provide with strainer drain assembly equal to McGuire 151.~~

~~Provide 17 gauge offset drain and trap assembly.~~

~~Faucet, drain, trim, and fittings shall be chrome plated finish.~~

~~Chrome plated supply tubing kit with quarter turn stops.~~

~~ADA Compliant.~~

~~SK-10 Double Bowl Etching Sink:~~

~~Epoxy countertop with integral undermount bowls provided by Div 10. Coordinate dimensions of holes required for faucet.~~
~~Deck mounted faucet with 4" centers, 9" swivel spout with 2.2 GPM aerator, and ceramic cartridges with wrist blade handles.~~

~~Faucet: Equal to Chicago Faucets W4D-L9E1-317ABCP.~~

~~Provide with strainer drain assembly equal to McGuire 151.~~

~~Provide 17 gauge offset drain and trap assembly.~~

~~Faucet, drain, trim, and fittings shall be chrome plated finish.~~

~~Chrome plated supply tubing kit with quarter turn stops.~~

~~SK-11 Single Bowl Paper Sink:~~

~~Floor standing utility sink with one 36" x 36" x 6" deep bowls, 14 gauge 304 stainless steel sink with 12" high backsplash with 8" faucet center punching, and center drain. Four 1-5/8" diameter stainless steel legs with adjustable feet.~~
~~Drain assembly shall have 90° valve outlet with lever handle and support arm at front of fixture.~~
~~Deck mounted faucet with 4" centers, 9" swivel spout with 2.2 GPM aerator, and ceramic cartridges with wrist blade handles.~~

~~Faucet: Equal to Chicago Faucets W4D-L9E1-317ABCP.~~

~~Provide with strainer drain assembly equal to McGuire 151.~~

~~Provide 17 gauge offset drain and trap assembly.~~

~~Faucet, drain, trim, and fittings shall be chrome plated finish.~~

~~Chrome plated supply tubing kit with quarter turn stops. – ADDENDUM #2.~~

E. EWC-1: ADA Electric Bottle Filling Station:

1. Wall recessed, ADA, barrier free, refrigerated, filtered, bottle filling station with stainless steel finish. Bottle Filler shall be sensor-actuated, with auto shut-off timer, bottle counter, and replaceable filter.

   a. Basis of Design: Sloan Drop-Spot DRS100-FIL-REF-SS.

   b. Wall recessed with manufacturer's in-wall support carrier frame.

c. Stainless steel trim.

d. Stainless steel lower covers.

e. Inlet filter, accessible from front cover.

f. Digital display on bottle filler.

g. Filter monitor and white LED status light. Red filter status light is not acceptable.

h. 115-volt @ 5.3 full load amps.

i. Capacity: 8.0 GPH @ 90˚F ambient air temp @ 50˚F chilled drinking water.

j. ADA Compliant

k. No Lead Design.

l. Provide spare filters as noted in Part 1 'Extra Materials' section.

~~EWC-2: Dual-Height ADA Electric Water Cooler & Bottle Filling Station:~~

~~Wall mounted, ADA, barrier free, refrigerated, filtered, dual basin water cooler with stainless steel finish. Provide vandal resistant kit and flexible bubbler. Bottle filler shall be located over the low bowl and shall be sensor-actuated, with auto shut-off timer, bottle counter, and replaceable filter.~~

~~Basis of Design: Sloan Drop-Spot DRS120-FIL-REF-SS.~~

~~Floor mounted, in wall support carrier.~~

~~Stainless steel basins.~~

~~Stainless steel lower covers.~~

~~Front activation button.~~

~~Inlet filter, accessible from front cover.~~

~~Digital display on bottle filler.~~

~~Filter monitor and white LED status light. Red filter status light is not acceptable.~~

~~115-volt @ 5.3 full load amps.~~

~~Capacity: 8.0 GPH @ 90˚F ambient air temp @ 50˚F chilled drinking water.~~

~~ADA Compliant~~

~~No Lead Design.~~

~~Provide spare filters as noted in Part 1 'Extra Materials' section.~~

F. MR-1 Mop Sink:

1. Floor mounted, 24" x 24" x 10" deep, molded stone sink. Wall mounted 8" center faucet with vacuum breaker, lever blade handles, pail hook, and wall brace. Provide

with accessories as indicated below. Fixture finish shall be white. Faucet, drain, trim, and fittings shall be chrome plated finish.

a. Fixture Basis of Design: Swanstone MS-2424

b. Faucet Basis of Design: Chicago Faucets 540-LD897SCP

c. Strainer: 3" stainless steel drain

d. Accessories: Mop hanger, hose and bracket, stainless steel wall guards

~~US-1 Double Bowl Utility Sink:~~

~~Floor standing utility sink with dual 24" x 24" x 13" deep bowls, soapstone sink with continuous rear ledge and centered 4" faucet center punching and center drains. Four formed legs with adjustable feet. Ledge mounted faucet with 4" centers, 9" swivel spout with 2.2 GPM aerator, and ceramic cartridges with wrist blade handles.~~

~~Sink: Equal to Swan MF-2F.~~

~~Faucet: Equal to Chicago Faucets W4D-L9E1-317ABCP.~~

~~Provide with strainer drain assembly equal to Just Manufacturing J-35.~~

~~Provide 17 gauge offset drain and trap assembly.~~

~~Chrome plated supply tubing kit with quarter turn stops.~~

~~Faucet, drain, trim, and fittings shall be chrome plated finish.~~

G. EE-1 Emergency Eyewash/Drench Hose Station:

1. Wall mounted, exposed, eye/face wash/drench hose with two spray heads, squeeze valve, 12' coiled hose, and wall bracket.

a. Eye/face wash / drench hose equal to Guardian Equipment G5046-TMV.

b. Spray head assembly with "flip-top" individual dust covers for each head, internal flow control valve and filter.

c. Chrome plated stainless steel squeeze valve operator, with hands free locking clip.

d. ANSI compliant identification sign.

e. Thermostatic mixing valve.

f. Locate at 48" AFF and within 12" of mop sink.

~~EE-2 Deck Mounted Emergency Eyewash/Drench Hose Station:~~

~~Deck mounted, eye/face wash/drench hose with two spray heads, squeeze valve, 8' reinforced hose, and counter mounted cup.~~

~~Eye/face wash / drench hose equal to Guardian Equipment G5022-TMV.~~

~~Spray head assembly with "flip-top" individual dust covers for each head, internal flow control valve and filter.~~

~~Chrome plated stainless steel squeeze valve operator, with hands free locking clip.~~

~~ANSI compliant identification sign.~~

~~Thermostatic mixing valve.~~

~~Locate adjacent to sinks as shown on architectural plans.~~

~~ES-1 Emergency Shower and Eyewash Station:~~

~~Floor mounted safety station with schedule 40 galvanized steel stand, fittings, and flanges with emergency shower, pull rod, eye/face wash basin and cover, with two spray heads and hold open valves.~~

~~Emergency station equal to Guardian G1902BC-TMV-SSH.~~

~~Stainless steel shower head, 20 gpm flow control, hold open valve with pull rod.~~

~~Stainless steel eye/face wash bowl with cover.~~

~~Two spray head assembles with internal flow control valve and filter.~~

~~Hold open eye/face wash valve also opens cover.~~

~~Orange pipe covers.~~

~~Top or back NPT inlet connections.~~

~~Back NPT outlet.~~

~~ANSI compliant identification sign.~~

~~Thermostatic mixing valve.~~

~~Locate as shown on plans. – ADDENDUM #2.~~

H. WB-1 Wall Box (Refrigerator Connection):

1. Wall recessed box with ½" cold water supply fitting, shutoff valves, and water hammer arrestor.

a. Equal to Oatey 39140.

I. WB-2 Wall Box (Clothes Washer Connection):

1. Steel, wall recessed box with ½" cold and hot water supply fitting, shutoff valves, water hammer arrestors, and 2" drain outlet fitting (field installed standpipe drain).

a. Equal to Oatey 38995.

J. WH-1 Interior Wall Hydrant:

1. Interior wall mounted hydrant with integral vacuum breaker, tee handle, ¾" cold water inlets, ¾" threaded hose outlet connection, polished stainless steel with wall escutcheon.

    a. Equal to Chicago Faucets 952-CP.

K. WH-2 Interior Wall Hydrant:

1. Interior narrow-wall mounted hydrant with integral vacuum breaker, loose key, ¾" cold and hot water inlets, ¾" threaded hose outlet connection, in stainless steel box with hinged flush mount cover, and cylinder keyed lock., with "water" stamped on cover.

    a. Equal to Zurn Z1327-EZ series.

L. WH-3 Exterior Wall Hydrant:

1. Exterior wall mounted automatic draining, freezeless, anti-siphon, wall hydrant with integral vacuum breaker, loose key, threaded hose connection, cast brass chrome finish faceplate.

    a. Equal to Zurn Z1321-C.

    b. Coordinate valve length with wall thickness and field conditions.

2.3 FIXTURE SUPPORTS

~~Water-Closet Supports:~~

~~Description: 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.~~

A. Lavatory Supports:

1. Type II, lavatory carrier with concealed arms and tie rod. Accessible-Fixture Support: Include rectangular steel uprights.
2. Accessible-Fixture Support: Include rectangular steel uprights.

~~Sink Supports:~~

~~Description: Type I, sink carrier with exposed arms and tie rods II, sink carrier with hanger plate, bearing studs, and tie rod for sink-type fixture. Include steel uprights with feet.~~

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Guard: Manufactured plastic enclosure for covering for hot- and cold-water supplies and trap and drain piping and complying with ADA requirements.

1. Manufacturers:

a. Plumberex.

b. Trubro

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 off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

~~Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.~~

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. 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.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

N. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

~~Install shower flow-control fittings with specified maximum flow rates in shower arms.~~

O. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

P. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.

Q. 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."

~~Set showers and service basins in leveling bed of cement grout.~~

R. 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.

~~Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."~~

~~Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."~~

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.

~~Install fresh batteries in sensor-operated mechanisms.~~

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

~~Install fresh batteries in sensor-operated mechanisms.~~

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.

~~COMMISSIONING~~

~~Commissioning Agent shall observe start up, testing and training as required to verify systems have been installed and operate per the contract documents.~~

END OF SECTION 22 40 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.2 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015, with Errata (2026).

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.

C. NEMA MG 00001 - Motors and Generators; 2024.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

D. Operation Data: Include instructions for safe operating procedures.

E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. 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 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Construction:

1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F (40 degrees C) environment.
3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.

B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

C. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.2 APPLICATIONS

A. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

B. Single phase motors for fans, pumps, blowers, and air compressors: Capacitor start type.

C. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.

D. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. 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.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. 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.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.5 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 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.

I. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

J. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

K. Three-phase motors 3 hp and larger used with variable frequency drives shall have factory installed grounding rings.

1. If motors are unavailable with factory grounding rings, provide one of the following methods to reduce damage from stray current:

a. Install a maintenance free, circumferential, conductive micro fiber shaft grounding ring (equal to AEGIS*SGR) to be field installed on the AC motor to discharge shaft currents to ground.

b. Install an inductive absorber equal to CoolBLUE on the power conductors between the VFD and motor.

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Applications:

1. Commercial:

a. Power Roof Ventilator (PRV):

1) Operating Mode: Constant cfm.

2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.

b. Hydronic Pump:

1) Operating Mode: Constant speed.

2) Input: Motor manufacturer to coordinate control requirements with the control board of the hydronic pump and/or specified sequence of operation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with 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 ensure agreement with nameplate.

END OF SECTION 23 05 13

SECTION 23 05 19 - METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

1.2 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).

D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers:

1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
2. Moeller Instrument Company, Inc; _____: www.moellerinstrument.com/#sle.
3. Winters Instruments; _____: www.winters.com/#sle.

B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Steel with brass bourdon tube.
2. Size: 4-1/2 inch (115 mm) diameter.
3. Mid-Scale Accuracy: One percent.
4. Scale: Psi and KPa.

2.2 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa).

B. Needle Valve: Brass, 1/4 inch (6 mm) NPT for minimum 150 psi (1034 kPa).

C. Pulsation Damper: Pressure snubber, brass with 1/4 inch (6 mm) connections.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
2. Weksler Glass Thermometer Corp; _____: www.wekslerglass.com/#sle.

3. Winters Instruments; _____: www.winters.com/#sle.

B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

1. Size: 9 inch (225 mm) scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch (20 mm) NPT brass.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

2.4 DIAL THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
2. Weksler Glass Thermometer Corp; _____: www.wekslerglass.com/#sle.
3. Winters Instruments; _____: www.winters.com/#sle.

B. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.

1. Size: 5 inch (125 mm) diameter dial.
2. Lens: Clear glass.
3. Accuracy: 1 percent.
4. Calibration: Degrees F.

2.5 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

C. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

E. Provide instruments with scale ranges selected according to service with largest appropriate scale.

F. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

G. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 SCHEDULE

A. Pressure Gauges, Location and Scale Range:

1. Pumps, 0 to ____ psi (0 to ____ kPa).
2. Expansion tanks, 0 to ____ psi (0 to ____ kPa).

B. Stem Type Thermometers, Location and Scale Range:

1. Headers to central equipment, 0 to ____ degrees F (0 to ____ Degrees C).
2. Boilers - inlets and outlets, 0 to ____ degrees F (0 to ____ Degrees C).

C. Thermometer Sockets, Location:

1. Control valves 1 inch (25 mm) & larger - inlets and outlets.
2. Reheat coils - inlets and outlets.
3. Cabinet heaters - inlets and outlets.
4. Unit heaters - inlets and outlets.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Globe valves.

B. Ball valves.

C. Butterfly valves.

D. Check valves.

E. Gate valves.

F. Chainwheels.

1.2 ABBREVIATIONS AND ACRONYMS

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. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. WOG: Water, oil, and gas.

1.3 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

D. ASME B31.9 - Building Services Piping; 2025.

E. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

F. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.

G. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).

H. MSS SP-67 - Butterfly Valves; 2022.

I. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.

J. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.

K. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

L. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.

M. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

N. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided; 2018.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.5 QUALITY ASSURANCE

A. Manufacturer:

1. Obtain valves for each valve type from single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
2. Protect valve parts exposed to piped medium against rust and corrosion.
3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
5. Secure check valves in either the closed position or open position.
6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:

1. Maintain valve end protection and protect flanges and specialties from dirt.

a. Provide temporary inlet and outlet caps.

b. Maintain caps in place until installation.

2. Store valves in shipping containers and maintain in place until installation.

a. Store valves indoors in dry environment.

b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:

1. Handle large valves with sling, modified to avoid damage to exposed parts.
2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.1 APPLICATIONS

A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

B. Provide the following valves for the applications if not indicated on drawings:

1. Throttling (Hydronic): ~~Butterfly, Ball, Globe, and Angle~~Butterfly and Ball.
2. Isolation (Shutoff): Butterfly, Gate, Ball, and Plug.
3. Swing Check (Pump Outlet):

a. Size 2 inch (50 mm, DN) and Smaller: Bronze with bronze disc.

b. Size 2-1/2 inch (65 mm, DN) and Larger: Iron with ~~lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat~~lever and weight, lever and spring, or center-guided with resilient seat.

4. Dead-End: Butterfly, single-flange (lug) type.

C. Required Valve End Connections for Non-Wafer Types:

1. Steel Pipe:

a. Size 2 inch (50 mm, DN) and Smaller: Threaded ends.

b. Size 2-1/2 inch (65 mm, DN) and Larger: ~~Grooved~~Flanged ends.

2. Copper Tube:

a. Size 2 inch (50 mm, DN) and Smaller: Threaded or pressure seal ends, except solder-joint valve-ends.

b. Size 2-1/2 inch (65 mm, DN) and Larger: ~~Grooved~~Flanged ends.

D. Chilled Water Valves:

1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:

a. Threaded or pressure seal ends.

b. Ball: Full port, one piece, brass trim.

c. Swing Check: Bronze disc, Class.

d. Globe: Bronze disc, Class 125.

2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:

a. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Threaded ends.

b. Single-Flange Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), aluminum-bronze disc, EPDM seat, 200 CWP.

c. Single-Flange Butterfly: 14 inch (350 mm, DN) to 24 inch (600 mm, DN), aluminum-bronze disc, EPDM seat, 150 CWP.

d. Swing Check: Metal seats, Class 125.

e. Swing Check with Closure Control: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), lever and spring, Class 125.

f. Gate: NRS, Class 125.

g. Globe: Class 125.

E. Heating Hot Water Valves:

1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:

a. Threaded or pressure seal ends.

b. Ball: Full port, one piece, brass trim.

c. Swing Check: Bronze disc, Class 125.

d. Gate: NRS, Class 125.

e. Globe: Bronze disc, Class 125.

2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:

a. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Threaded ends.

b. Single-Flange Butterfly: 14 inch (350 mm, DN) to 24 inch (600 mm, DN), aluminum-bronze disc, EPDM seat, 150 CWP.

c. Swing Check: Metal seats, Class 125.

d. Swing Check: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), lever and spring closure control, Class 125.

e. Gate: NRS, Class 125.

f. Globe: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), Class 125.

2.2 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:

1. Handwheel: Valves other than quarter-turn types.

2. Hand Lever: Quarter-turn valves 6 inch (150 mm, DN) and smaller.
3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: Provide 2 inch (50 mm, DN) stem extensions and the following features:

1. Gate Valves: Rising stem.
2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: Extended neck.

E. Valve-End Connections:

1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Solder Joint Connections: ASME B16.18.

F. General ASME Compliance:

1. Building Services Piping Valves: ASME B31.9.

2.3 BRONZE, GLOBE VALVES

A. CWP Rating: Class 125: 200 psi (1,380 kPa):

1. Comply with MSS SP-80, Type 1.
2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
3. Ends: Threaded or solder joint.
4. Stem and Disc: Bronze or PTFE.
5. Packing: Asbestos free.
6. Handwheel: Malleable iron.

2.4 IRON, GLOBE VALVES

A. CWP Ratings: Class 125: 200 psi (1,380 kPa) and Class 250: 500 psi (3,450 kPa):

1. Comply with MSS SP-85, Type I.
2. Body: Gray iron; ASTM A126, with bolted bonnet.
3. Ends: Flanged.
4. Trim: Bronze.
5. Packing and Gasket: Asbestos free.
6. Operator: Handwheel or chainwheel.

2.5 BRASS, BALL VALVES

A. Two Piece, Full Port with ~~Stainless Steel~~Stainless Steel Trim and ~~Female Thread or Solder~~Female Thread or Solder Connections:

1. Comply with MSS SP-110.
2. SWP Rating: 150 psi (1,035 kPa).
3. WOG Rating: 600 psi (4,140 kPa).

4. Vacuum Rating: 28.9 in-Hg (97.9 kPa).
5. Body: Forged brass.
6. Seats: PTFE.
7. Stem: ~~Stainless Steel~~Stainless Steel.
8. Ball: Chrome-plated brass.
9. Hose-End Applications: Provide 3/4-inch (20 mm) hose connection. Include cap, gasket, and chain or tether.
10. Operator: Lockable handle and memory stop.

B. Two Piece, Full Port with Press Connection:

1. WOG Rating: 250 psi (1,724 kPa).
2. Body: Forged brass.
3. Seats: EPDM.
4. Ball: Chrome-plated brass.
5. Blowout Proof Stem: Forged brass.
6. Hose-End Applications: Provide 3/4-inch (20 mm) hose connection. Include cap, gasket, and chain or tether.
7. Operator: Provide lockable handle.
8. Maximum Service Temperature: 250 degrees F (121.1 degrees C).

2.6 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Wafer and Lug Style:

1. Class 125 or 150.
2. Comply with MSS SP-67, Type I.
3. Wafer Style, CWP Ratings:
   a. Sizes 2 to 12 inches (50 to 300 mm, DN): 200 psi (1380 kPa).
   b. Sizes 14 to 24 inches (350 to 600 mm, DN): 150 psi (1034 kPa).
4. Lug Style, CWP Ratings:
   a. Sizes 2 to 12 inches (50 to 300 mm, DN): 250 psi (1725 kPa).
   b. Sizes 14 to 24 inches (350 to 600 mm, DN): 150 psi (1034 kPa).
5. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
6. Stem: One or two-piece stainless steel.
7. Seat: NBR.
8. Disc: Aluminum-bronze.
9. Removable Manual Actuator: Lockable handle or worm-gear-connected handwheel with open/close position indication.
10. Service Temperature Range: Minus 30 to 250 degrees F (Minus 34.4 to 121.1 degrees C).

2.7 BRASS, INLINE CHECK VALVES

A. Class 150: CWP Rating: 200 psi (1,380 kPa) .

B. Maximum Service Temperature: 250 degreess F (121.1 degreess C).

C. Body: Forged brass.

D. Disc: Forged brass.

E. Seal: PTFE, bubble tight.

F. End-Connections: ~~Press~~Threaded.

2.8 BRASS, HORIZONTAL SWING CHECK VALVES

A. Threaded End-Connections:

1. Class 125: CWP Rating: 200 psi (1,380 kPa).
2. Body: Forged brass.
3. Disc: Forged brass.
4. Hinge-Pin, Screw, and Cap: Forged brass.

2.9 BRONZE, SWING CHECK VALVES

A. Class 125:

1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. WSP Rating: 200 psi (1,380 kPa).
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded or soldered.
6. Disc: Bronze.

2.10 IRON, FLANGED END SWING CHECK VALVES

A. Class 125:

1. 150 psi (1,035 kPa) with metal seats.
2. 200 psi (1,380 kPa) with metal seats and nonmetallic-to-metal seats.

2.11 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125:

1. Comply with MSS SP-71, Type I.
2. Sizes 2-1/2 to 12 inch (65 to 300 mm, DN): CWP Rating; 200 psi (1,380 kPa).
3. Body Design: Clear or full waterway.
4. Body Material: ASTM A126, gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Gasket: Asbestos free.
8. Closer Control: Factory installed, exterior lever, and spring or weight.

2.12 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Globe:

1. Comply with MSS SP-125.
2. Sizes 2-1/2 to 12 inch (65 to 300 mm, DN): CWP Rating; 200 psi (1,380 kPa).
3. Body Material: ASTM A126, gray iron.

4. Style: Spring loaded.
5. Ends: Flanged.
6. Metal Seat: Bronze.

2.13 BRONZE, GATE VALVES

A. Rising Stem or OS&Y:

1. Pressure-Temperature Range: MSS SP-80, Type I.
2. Class 125:
3. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
4. End Connections: Threaded or solder.
5. Stem: Bronze.
6. Disc: Solid wedge; bronze.
7. Packing: Asbestos free.
8. Handwheel Operator: Malleable iron, bronze, or aluminum.

B. Nonrising Stem or NRS:

1. Pressure-Temperature Range: MSS SP-80, Type I.
2. Class 125:
3. Class 150: CWP Rating; 300 psi (2,070 kPa).
4. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
5. Ends Connections: Threaded or solder.
6. Stem: Bronze.
7. Disc: Solid wedge; bronze.
8. Packing: Asbestos free.
9. Handwheel Operator: Malleable iron, bronze, or aluminum.

2.14 IRON, GATE VALVES

A. NRS or OS&Y:

1. Comply with MSS SP-70, Type I.
2. Body Material: Gray iron with bolted bonnet.
3. Ends: Flanged.
4. Trim: Bronze.
5. Disc: Solid wedge.
6. Packing and Gasket: Asbestos free.

PART 3 EXECUTION

3.1 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.2 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install check valves where necessary to maintain direction of flow as follows:

1. Swing Check: Install horizontal maintaining hinge pin level.
2. Orient plate-type and center-guided into horizontal or vertical position, between flanges.

D. Provide chainwheels on operators for valves 4 NPS (100 DN) and larger where located 96 inches (2.4 m) or more above finished floor, terminating 60 inches (1.5 m) above finished floor.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components.

1.2 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2025.

D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.

E. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).

F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

G. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

I. FM (AG) - FM Approval Guide; Current Edition.

J. MFMA-4 - Metal Framing Standards Publication; 2004.

K. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

L. UL (DIR) - Online Certifications Directory; Current Edition.

M. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.

    a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.

    c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

    d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Prefabricated Trapeze-Framed Metal Strut Systems:

1. Manufacturers:

    a. B-Line, a brand of Eaton Corporation; _____: www.eaton.com/#sle.

    b. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.

    c. Gripple, Inc; Fast Track - Standard: www.gripple.com/#sle.

    d. Unistrut, a brand of Atkore International Inc; _____: www.unistrut.com/#sle.

2. MFMA-4 compliant, prefabricated, side-loading continuous-slot metal strut channel bracket with associated tracks, fittings, and related accessories.
3. Strut Channel or Bracket Material:

    a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.

    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.

4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm).
5. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
6. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

C. Strut Channels:

1. Manufacturers:
   a. B-Line, a brand of Eaton Corporation; _____: www.eaton.com/#sle.
   b. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
   c. Unistrut, a brand of Atkore International Inc; _____: www.unistrut.com/#sle.
2. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
3. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

D. Channel Nuts:

1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.

E. Hanger Rods:

1. Threaded zinc-plated steel unless otherwise indicated.
2. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2 inch (13 mm) diameter.
   b. Piping up to 1 inch (25 mm, DN): 1/4 inch (6 mm) diameter.
   c. Piping larger than 1 inch (25 mm, DN): 3/8 inch (10 mm) diameter.
   d. Trapeze Support for Multiple Pipes: 3/8 inch (10 mm) diameter.

F. Pipe Supports:

1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up To 122 degrees F (50 degrees C):
   a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
   b. Support From Below: MSS SP-58 Types 35 through 38.

G. Beam Clamps:

1. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.

2. Beam C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
3. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).
4. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
5. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
6. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish,
7. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
8. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

H. Riser Clamps:

1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch (15 to 200 mm, DN).

I. Strut Clamps:

1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.
2. Cushioned Pipe or Tubing Strut Clamp: Provide strut clamp with thermoplastic elastomer cushion having dielectric strength of 670 V/mil (26,398,000 V/m).
3. Service Temperature Range: Minus 65 to 275 degrees F (Minus 53.8 to 135 degrees C).

J. Pipe Hangers:

1. Clevis Hangers, Adjustable:

   a. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.

   b. Light-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.

   c. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.

K. Pipe Shields for Insulated Piping:

1. General Construction and Requirements:

   a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.

   b. Shields Material: UV-resistant polypropylene with glass fill.

   c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch (321 mm).

d. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).

e. Maximum Service Temperature: 178 degrees F (81 degrees C).

f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

L. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Steel: Use beam-ceiling clamps, beam clamps, machine bolts, or welded threaded studs.
4. Sheet Metal: Use sheet metal screws.
5. Wood: Use wood screws.
6. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

a. Comply with MFMA-4.

b. Channel Material: Use galvanized steel.

c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

G. Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

I. Secure fasteners according to manufacturer's recommended torque settings.

J. Remove temporary supports.

END OF SECTION 23 05 29

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe markers.

E. Ceiling tacks.

1.2 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting: Identification painting.

1.3 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2025.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Chart and Schedule: 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.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Control Panels: Nameplates.

C. Dampers: Ceiling tacks, where located above lay-in ceiling.

D. Ductwork: Nameplates.

E. Piping: Tags.

F. Pumps: Nameplates.

G. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.2 NAMEPLATES

A. Letter Color: White.

B. Letter Height: 1/4 inch (6 mm).

C. Background Color: Black.

D. Plastic: Comply with ASTM D709.

2.3 TAGS

A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 STENCILS

A. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch (20-30 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 1/2 inch (15 mm) high letters.
2. 1-1/2 to 2 inch (40-50 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 3/4 inch (20 mm) high letters.
3. 2-1/2 to 6 inch (65-150 mm) Outside Diameter of Insulation or Pipe: 12 inch (300 mm) long color field, 1-1/4 inch (30 mm) high letters.
4. 8 to 10 inch (200-250 mm) Outside Diameter of Insulation or Pipe: 24 inch (600 mm) long color field, 2-1/2 inch (65 mm) high letters.
5. Over 10 inch (250 mm) Outside Diameter of Insulation or Pipe: 32 inch (800 mm) long color field, 3-1/2 inch (90 mm) high letters.
6. Ductwork and Equipment: 2-1/2 inch (65 mm) high letters.

B. Stencil Paint: As specified in Section 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.

2.5 PIPE MARKERS

A. Color: Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

D. Color code as follows:

1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2.6 CEILING TACKS

A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

3.2 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09 91 23.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

F. Install ductwork with plastic nameplates. 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.

G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 23 05 53

SECTION 23 05 93 - 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, steam, and refrigerating~~hydronic systems.

C. Measurement of final operating condition of HVAC systems.

1.2 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

C. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

1. Submit six weeks prior to starting the testing, adjusting, and balancing work.
2. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
3. Include at least the following in the plan:

    a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

    b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

    c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

    d. Final test report forms to be used.

    e. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).

    f. Time schedule for deferred or seasonal TAB work, if specified.

    g. False loading of systems to complete TAB work, if specified.

h. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

E. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

1. Revise TAB plan to reflect actual procedures and submit as part of final report.
2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
6. Include the following on the title page of each report:

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 Contractor.

h. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:

1. AABC (NSTSB), AABC National Standards for Total System Balance.
2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
3. SMACNA (TAB).

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. TAB Agency Qualifications:

1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of ~~three~~five years documented experience.
3. Certified by one of the following:

    a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.

    b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.

    c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.

D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

A. Verify that systems are complete and operable 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. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus 5 percent ~~or~~and~~minus~~ 5zero ~~percent~~ of design for supply systems and plus or minus ~~10~~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~~zero of design to space. Adjust outlets and inlets in space to within plus 10 percent or minus 105 percent of design.

C. Hydronic Systems: Adjust to within plus 10 percent ~~or~~and~~minus 10~~zero ~~percent~~ of design.

3.5 RECORDING AND 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.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

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 extend 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. Provide drive changes required. 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, outside air, return air, and exhaust dampers for design conditions.

J. 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.

K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.

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 unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 SCOPE

A. Test, adjust, and balance the following:

1. HVAC Pumps.
2. Hot Water ~~Tube~~ Boilers.
3. Air Cooled Water Chillers.
4. Air Cooled Refrigerant Condensers.
5. Air Coils.
6. Air Handling Units.
7. Fans.
8. Air Terminal Units.
9. Air Inlets and Outlets.

3.9 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Sheave Make/Size/Bore.

B. Pumps:

1. Identification/number.
2. Manufacturer.
3. Size/model.

4. Impeller.
5. Service.
6. Design flow rate, pressure drop, BHP.
7. Actual flow rate, pressure drop, BHP.
8. Discharge pressure.
9. Suction pressure.
10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

C. Combustion Equipment:

1. Boiler manufacturer.
2. Model number.
3. Serial number.
4. Firing rate.
5. Overfire draft.
6. Burner manifold gas pressure.
7. Percent carbon monoxide (CO).
8. Percent carbon dioxide (CO2).
9. Percent oxygen (O2).
10. Percent excess air.
11. Flue gas temperature at outlet.
12. Ambient temperature.

D. Air Cooled Condensers:

1. Identification/number.
2. Location.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Entering DB air temperature, design and actual.
7. Leaving DB air temperature, design and actual.
8. Number of compressors.

E. Chillers:

1. Identification/number.
2. Manufacturer.
3. Capacity.
4. Serial number.
5. Evaporator entering water temperature, design and actual.
6. Evaporator leaving water temperature, design and actual.
7. Evaporator pressure drop, design and actual.
8. Evaporator water flow rate, design and actual.

F. Cooling Coils:

1. Identification/number.

2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air WB temperature, design and actual.
7. Leaving air DB temperature, design and actual.
8. Leaving air WB temperature, design and actual.
9. Water flow, design and actual.
10. Water pressure drop, design and actual.

G. Heating Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.

H. Air Moving Equipment:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

I. Exhaust Fans:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

J. Duct Traverses:

1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.

K. Terminal Unit Data:

1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Minimum design air flow.
8. Maximum design air flow.
9. Maximum actual air flow.
10. Inlet static pressure.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Duct insulation.

B. Jacketing and accessories.

1.2 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.

D. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

E. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2025.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, FLEXIBLE

A. Manufacturer:

1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
2. Johns Manville; _____: www.jm.com/#sle.
3. Knauf Insulation; Performance+ Duct Wrap: www.knaufinsulation.com/#sle.
4. Manson Insulation, a company of Knauf Insulation; AK FLEX with ECOSE (High-Temperature Application and Diameters Exceeding 10"): www.imanson.com/#sle.
5. Owens Corning Corporation; SOFTR Duct Wrap FRK: www.owenscorning.com/en-us/#sle.

B. Insulation: ASTM C553; flexible, noncombustible blanket.

1. K (Ksi) value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 250 degrees F (121 degrees C).
3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Insulation: ASTM C1393; pipe and tank, end grain adhered to jacket.

1. K (Ksi) Value: ASTM C177, 0.27 at 75 degrees F (0.034 at 24 degrees C).
2. Maximum Service Temperature: 850 degrees F (454 degrees C).
3. Maximum Moisture Absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

E. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.3 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible.

1. K (Ksi) Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F (232 degrees C).
3. Maximum Water Vapor Absorption: 5.0 percent.
4. Maximum Density: 8.0 pcf (128 kg/cu m).

B. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

C. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:

1. Aeroflex USA; AEROFLEX Breathe-EZ: www.aeroflexusa.com/#sle.
2. Armacell LLC; AP ArmaFlex: www.armacell.us/#sle.
3. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.

1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
2. Maximum Service Temperature: 180 degrees F (82 degrees C).
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.5 JACKETING AND ACCESSORIES

A. Aluminum Jacket:

1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
2. Thickness: 0.016 inch (0.40 mm) sheet.
3. Finish: Smooth.
4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
5. Fittings: 0.016 inch (0.40 mm) thick die-shaped fitting covers with factory-attached protective liner.
6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Test ductwork for design pressure prior to applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated Ducts 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.

C. Slope exterior ductwork to shed water.

3.3 SCHEDULES

A. Exhaust Ducts Within 10 ft (3 m) of Exterior Openings:

1. Flexible Glass Fiber Duct Insulation: 1-1/2 inches thick.

B. Outside Air Intake Ducts:

1. Flexible Glass Fiber Duct Insulation: 2 inches thick.

C. Outside Air and Exhaust Air Plenums:

1. Rigid Glass Fiber Duct Insulation: 2 inches thick.

D. Supply Ducts:

1. Flexible Glass Fiber Duct Insulation: 1-1/2 inches thick.

END OF SECTION 23 07 13

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Flexible removable and reusable blanket insulation.

C. Jacketing and accessories.

1.2 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.

D. ASTM C1393 - Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks; 2025.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

F. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, FLEXIBLE

A. Manufacturers:

1. Knauf Insulation: www.knaufinsulation.com/#sle.
2. Manson Insulation, a company of Knauf Insulation: www.imanson.com/#sle.

B. Insulation: ASTM C1393; pipe and tank, end grain adhered to jacket.

1. K (Ksi) Value: ASTM C177, 0.27 at 75 degrees F (0.034 at 24 degrees C).
2. Maximum Service Temperature: 850 degrees F (454 degrees C).
3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film with pressure-sensitive rubber-based adhesive.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:

1. Aeroflex USA; AEROFLEX Self-Seal: www.aeroflexusa.com/#sle.
2. Armacell LLC; AP ArmaFlex: www.armacell.us/#sle.
3. K-Flex USA LLC; Insul-Tube: www.kflexusa.com/#sle.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.

1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
2. Maximum Service Temperature: 180 degrees F (82 degrees C).
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.4 JACKETING AND ACCESSORIES

A. PVC Plastic.

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
    a. Minimum Service Temperature: 0 degrees F (minus 18 degrees C).
    b. Maximum Service Temperature: 150 degrees F (66 degrees C).
    c. Moisture Vapor Permeability: 0.002 perm inch (0.0029 ng/(Pa s m)), maximum, when tested in accordance with ASTM E96/E96M.
    d. Thickness: 10 mil, 0.010 inch (0.25 mm).
    e. Connections: Brush on welding adhesive.

B. Aluminum Jacket:

1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
2. Thickness: 0.016 inch (0.40 mm) sheet.
3. Type: Factory-applied, self-adhesive jacketing.
4. Finish: Smooth.
5. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
6. Fittings: 0.016 inch (0.40 mm) thick die-shaped fitting covers with factory-attached protective liner.
7. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Insulated Pipes Conveying Fluids Below Ambient Temperature:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

D. For hot piping conveying fluids 140 degrees F (60 degrees C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

E. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.

F. Inserts and Shields:

1. Application: Piping 1-1/2 inches (40 mm) diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.

G. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with canvas jacket sized for finish painting.

H. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV-resistant finish for flexible elastomeric cellular insulation without jacketing.

3.3 SCHEDULE

A. Heating Systems:

1. Heating Water Supply and Return:

a. 1-1/4" piping and smaller: Preformed Fiberglass: 1-1/2 inches thick.

b. 1-1/2" piping and larger: Preformed Fiberglass: 2 inches thick.

B. Cooling Systems:

1. Chilled Water:

a. All Sizes: Preformed Fiberglass: 1 inch thick.

2. Outdoor Chilled Water:

a. All Sizes: Preformed Fiberglass: 1-1/2 inches thick.

3. Cold Condensate Drains:

a. All Sizes: Preformed Flexible Elastomeric: 3/4 inches thick.

4. Refrigerant ~~Suction~~:

a. Smaller than 1" piping: Preformed Flexible Elastomeric: 3/4 inches thick.

b. 1" piping and larger: Preformed Flexible Elastomeric: 1 inches thick.

END OF SECTION 23 07 19

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

~~SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC~~

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 control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Division 23 Section "Sequence of Operation" for requirements that relate to this Section.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. GUI: Graphical User Interface.

C. I/O: Input/output.

D. BACnet: Building Automation and Control Network.

E. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

F. MS/TP: Master slave/token passing.

G. PC: Personal computer.

H. RTD: Resistance temperature detector.

1.4 REFERENCE STANDARDS

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

B. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

E. UL 508 - Industrial Control Equipment; Current Edition, Including All Revisions.

1.5 SYSTEM DESCRIPTION

A. The system shall be Direct Digital Control (DDC) with equipment furnished, installed, and guaranteed by the Temperature Control Contractor.

B. The system shall be fully open architecture platform, BACnet or LON.

C. The Temperature Control Contractor shall provide a complete system operating in multiuser, multitasking environment on a network of micro processor based direct digital automatic temperature controls as herein specified, including all components as indicated and required to achieve the Sequence of Operation and connection to devices specified and furnished with equipment under other Sections.

D. Control system shall permit web-browser based interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

E. Work includes, but is not limited to, the following;

1. Hardware, microprocessors, controllers.
2. Software.
3. Thermostats and sensors.
4. Relays and switches.
5. Control Valves and actuators.
6. Control Dampers and actuators.
7. Control Panels and cabinets.
8. Application specific controllers.
9. I/O Devices, transducers.
10. Variable Frequency Controllers (VFDs).
11. Control Wiring and wiring of Control Devices.

1.6 .

1.7 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

C. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

D. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.

4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has a minimum of 5-years experience in automatic control systems for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

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. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

E. Comply with ASHRAE 135-P for BACnet interoperability with all devices.

F. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

C. Store control components indoors in clean, dry space with uniform temperature to prevent condensation. Protect control components from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.10 COORDINATION

A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

D. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

PART 2 PRODUCTS

2.1 CONTROL SYSTEM

A. Manufacturer shall be one of the following:

1. Honeywell.
2. Johnson Controls, Inc.
3. Siemens Building Technologies, Inc.
4. TAC/IA (Maine Controls).
5. Trane.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment and programmed to control mechanical systems. An operator workstation permits interface via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

C. Provide UPS back-up for computer head end system. UPS shall provide a minimum of 30-minutres of power supply.

2.2 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.

b. Discrete/digital, analog, and pulse I/O.

c. Monitoring, controlling, or addressing data points.

d. Software applications, scheduling, and alarm processing.

e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.

b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.

c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.

d. Remote communications.

e. Maintenance management.

f. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.

b. Discrete/digital, analog, and pulse I/O.

c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

C. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

D. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.

1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig (89.63 kPa).
2. Proportional band shall extend from 2 to 20 percent for 5 psig (34.47 kPa).
3. Authority shall be 20 to 200 percent.
4. Air-supply pressure of 18 psig (124.11 kPa), input signal of 3 to 15 psig (103.42 kPa), and output signal of zero to supply pressure.
5. Gages: 1-1/2 inches (38 mm) in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.4 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.

b. Output: 4 to 20 mA.

c. Building Static-Pressure Range: 0- to 0.25-inch wg.

d. Duct Static-Pressure Range: 0- to 5-inch wg.

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

C. Current Sensors: Solid state, split core linear current sensors shall be provided where specified.

1. Linear output of 0-5 VDC, 0-10 VDC, or 4-20 mA.
2. Scale sensors so that average operating current is between 20-80% full scale.
3. Accuracy plus or minus 1.0% (5-100% full scale)
4. Operating frequency 50-600 Hz.
5. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing
6. Approvals CE, UL.

D. Water Flow Meters: Water flow meters shall be axial turbine style flow meters which translate liquid motion into electronic output signals proportional to the flow sensed.

1. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag.
2. Flow meters shall be ‘insertion’ type complete with ‘hot-tap’ isolation valves to enable sensor removal without water supply system shutdown.
3. Accuracy shall be + 2% of actual reading from 0.4 to 20 feet (609.6 cm) per second flow velocities.

E. Carbon Dioxide Sensors

1. Carbon Dioxide sensors shall be 0-10 Vdc, 2-10 Vdc, or 4-20 mA linear analog output type, with corrosion free gold-plated non-dispersive infrared sensing, designed for duct or wall mounting.
2. Sensor shall incorporate internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-2000 PPM with +/- 75 PPM accuracy at full scale.
3. Sensor shall have an LCD display that displays the sensor reading and status.

F. Annular Pitot Tube Flow Meter. Annular pitot tube shall be averaging type differential pressure sensors with four total head pressure ports and one static port made of austenitic stainless steel.

1. Sensor shall have an accuracy of ±.25% of full flow and a repeatability of ±.05% of measured value.
2. Transmitter shall be electronic and shall produce a linear output of 0-10 Vdc, 0-5 Vdc, or 4 to 20 mA dc corresponding to the required flow span.
3. The transmitter shall include non-interacting zero and span adjustments.

G. Nitrogen Monoxide and Nitrogen Dioxide Sensors

1. Nitrogen sensors shall be 0-10 Vdc, 2-10 Vdc, or 4-20 mA linear analog output type, with solid-state infrared sensing, designed for wall mounting.
2. Sensor shall incorporate internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-10 PPM with +/- 10% accuracy at full scale.
3. Where specified, sensor shall have an LCD display that displays the sensor reading and status.

H. Carbon Monoxide Sensors

1. Nitrogen Dioxide sensors shall be 0-10 Vdc, 2-10 Vdc, or 4-20 mA linear analog output type, with solid-state or electromechanical infrared sensing, designed for wall mounting.
2. Sensor shall incorporate internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-100 or 0-200 PPM with +/- 5% accuracy at full scale.
3. Where specified, sensor shall have an LCD display that displays the sensor reading and status.

I. Room Pressure Monitors

1. Wall recessed room pressure monitor with color touch screen display equal to Setra SRCM.
2. Monitoring of two spaces via on-board pressure sensors connected to ceiling probes with 1/8” ID tubing.
3. Capability to monitor space temperature, humidity and pressure.
4. Visual color change for normal, or alarm condition.
5. Customizable programming for display orientation and colors, and text.
6. 24 VAC power input.
7. 0-5 VDC or 0-10 VDC outputs.
8. Alarm output relay 120 VDC or 30 VDC.
9. BACnet compatible.
10. Accuracy: +/- 0.5% full scale range.
11. Non-repeatability: +/- 0.05% full scale range.
12. Operating temperature range: 32 dg F to 120 degrees Fahrenheit (48.89 degrees Celsius).

2.5 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

C. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

D. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

E. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

F. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

2.6 BTU METERS

A. Packaged control solution including controller with display, supply and return temperature sensors and insertion type flow meter equal to Onicon.

B. Controller input power shall be either 24v or 120v.

C. System shall be capable of communication with the DDC system through BACnet, MODBUS, LonWorks, or RS485.

1. Optional analog and pulse outputs.

D. Flow meter shall be dual turbine, insertion type with nickel plated brass stem.

1. +/- 1% accuracy across range.
2. Standard construction 150 degrees Fahrenheit (65.56 degrees Celsius) continuous rating, 200 degrees Fahrenheit (93.33 degrees Celsius) peak.
3. For use with steam and hot water heating, 316L stainless steel construction for 280 degrees Fahrenheit (137.78 degrees Celsius) continuous and 300 degrees Fahrenheit (148.89 degrees Celsius) peak rating.

2.7 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 inch (3810 mm). x lbf and breakaway torque of 300 inch (7620 mm). x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 inch (3810 mm). x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 inch (3810 mm). x lbf and breakaway torque of 300 inch (7620 mm). x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 inch (3810 mm). x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:

a. Parallel-Blade Damper with Edge Seals: 7 inch (177.8 mm)-lb/sq. ft. of damper.

b. Opposed-Blade Damper with Edge Seals: 5 inch (127 mm)-lb/sq. ft. of damper.

c. Parallel-Blade Damper without Edge Seals: 4 inch (101.6 mm)-lb/sq. ft of damper.

d. Opposed-Blade Damper without Edge Seals: 3 inch (76.2 mm)-lb/sq. ft. of damper.

e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position Spring Return).
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: 40 to 104 deg F.
10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

2.8 DAMPERS

A. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches (203.2 mm) and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-

plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 inch (1270 mm). x lbf; when tested according to AMCA 500-D.

2.9 AIRFLOW MEASURING STATIONS

A. Duct Airflow Station: Factory assembled combination of air straightener and multiport, self-averaging pitot tube station. Basis of design: Ruskin AMS.

1. Available Manufacturers:

a. Air Monitor Corporation.

b. Ruskin, Inc.

c. Wetmaster Co., Ltd.

2. Casing: Galvanized steel frame with duct flanges.
3. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches (76.2 mm) deep.
4. Sensing Manifold: Aluminum, bullet-nosed static pressure sensor tubes positioned on equal area basis.
5. Controls: Factory installed averaging controls with output to DDC system.

2.10 THERMOSTATS

A. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

B. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type, with adjustable set point in middle of range and adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

C. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (304.8 mm) of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet (609.6 cm).
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

D. Electric High-Limit Duct Sensor/Discharge Sensor.

E. Space Thermostats: Wall mounted microprocessor based.

1. DDC Thermostat with LCD readout, set-point, and manual occupant override. All thermostats shall be by a single manufacturer.

2. Combination DDC Thermostat with CO2 Sensor: Provide combination DDC thermostat with CO2 sensor (single enclosure) in spaces requiring both sensor devices. Thermostat shall include LCD readout, set-point, manual occupant override, CO2 readout, alarm, and adjustable CO2 alarm level.
3. In public spaces, and where noted on the drawings, provide blank DDC wall temperature sensors with override button but without LCD display.

2.11 LOCAL CONTROL PANELS

A. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.

B. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.

C. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

D. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

E. All wiring shall be neatly installed in plastic trays or tie-wrapped.

F. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

G. Provide UPS back-up systems at all control panels. UPS shall provide a minimum of 30-minutres of power supply.

2.12 VARIABLE FREQUENCY CONTROLLERS (VFDS)

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following;

1. ABB.
2. Honeywell.
3. Johnson Controls.
4. Reliance.
5. Toshiba.
6. Yaskawa.

B. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, premium-efficiency induction motor by adjusting output voltage and frequency. Units shall be provided with main power disconnect.

C. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

E. Unit Operating Requirements:

1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 5 percent.
3. Capable of driving full load, under the following conditions, without derating:

   a. Ambient Temperature: Minus 10 to 40 deg C.

   b. Humidity: Less than 95 percent (non-condensing).

   c. Altitude: 3300 feet (100584 cm).

4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent.
6. Overload Capability: 1.5 times the base load current for 60 seconds.
7. Starting Torque: 150 percent of rated torque or as indicated.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over an 40:1 speed range.

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 1 second.
4. Deceleration: 2 to a minimum of 1 second.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:

1. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
2. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 20 performance.
3. Instantaneous line-to-line and line-to-ground overcurrent trips.
4. Reverse-phase protection.
5. Short-circuit protection.
6. Motor overtemperature fault.

H. Automatic Reset and Restart: To attempt ten restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

I. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

J. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.

K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.

L. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Line fault.

M. Alphanumeric Display: Liquid-crystal type, 16 characters, minimum.

N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

O. Indicating Devices: Digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

P. Control Signal Interface: Provide from VFC Lon interface communications module, with the following;

1. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from other control systems:

a. 0 to 10-V dc.

b. 4 to 20 mA.

c. Keypad display for local hand operation.

2. Output Signal Interface:

a. A minimum of 1 analog output signal (4-20 mA), which can be programmed to either of the following:

1) DC-link voltage (VDC).

2) Set-point frequency (Hz).

3. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    a. Motor running.
    b. Set-point speed reached.
    c. Fault and warning indication (overtemperature or overcurrent).
    d. PID high or low speed limits reached.

Q. Communications: Provide an LON communications card allowing VFC to be used with an external system within a multidrop LAN configuration. Provide capability for VFC to retain these settings within the nonvolatile memory. LON communications module connected directly with LON communications bus for information and programming.

R. Accessories
1. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
2. Control Relays: Auxiliary and adjustable time-delay relays.
3. Standard Displays:
    a. Output frequency (Hz).
    b. Set-point frequency (Hz).
4. Motor current (amperes).
    a. Motor full-load current (amperes).
    b. DC-link voltage (VDC).
    c. Motor torque (percent).
    d. Motor speed (rpm).
    e. Motor output voltage (V).
    f. Motor output power (kW).
    g. Status: Forward or reverse.
5. Historical Logging Information and Displays:
6. Total run time.
7. Fault log, maintaining last four faults.

2.13 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Install guards on thermostats (not provided with blank sensors) in the following locations:

1. Entrances.
2. Public areas.

D. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1219.2 mm) above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

H. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

I. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable shall be run together and supported every 4-feet. All wiring shall be at right angles to building structure.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 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.

B. Commissioning Agent: Coordinate and schedule with owners Commissioning Agent, calibrating, adjusting, and verification of all instrumentation controls system operating points.

C. Perform the following field tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
5. Test each point through its full operating range to verify that safety and operating control set points are as required.
6. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
7. Test each system for compliance with sequence of operation.
8. Test software and hardware interlocks.

D. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.

    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.

    c. Verify that spare I/O capacity has been provided.

    d. Verify that DDC controllers are protected from power supply surges.

E. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

B. Adjust initial temperature and system set points.

C. Occupancy Adjustments: The controls manufacturer shall provide a representative for a service call monthly to confirm proper operation of the systems and equipment. The service calls shall be for the one-year warranty period and commence one month after substantial completion.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel familiar with the building’s system hardware, programming and accessories to adjust, operate, and maintain HVAC instrumentation and controls. Training shall commence one building control systems are substantially complete operational under automatic control per the Sequence of Operation.

B. Provide a minimum of 32-hours of on-site technical and operational training. Refer to Division 01 Section "Demonstration and Training." Sessions shall occur during normal working hours.

1. An initial training session (8 hours) shall include a walk-through of the building indicating location of control panels, systems components, and operator workstation. System log in and basic navigation of the graphical user interface shall be reviewed as well as making modifications and adjustments. Representative shall assist in

creation of log in information for Owner's staff at varying security levels. Each system or plant type GUI shall be reviewed in detail.

2. A second session (8 hours) shall occur once the Owner has had opportunity to work with the systems and has developed questions, around one month after building occupancy. Training shall include datalogging, trending, and alarm resolution and manual overrides in addition to questions raised by the Owner's staff. Background points list, location and navigation, point naming and relationships should be reviewed.
3. Representative shall attend related training sessions (8 hours) for electrical (ex: generator & emergency power) or other mechanical trainings (ex: mini-splits, chiller, and air handlers) and speak about the connection to building controls and operation.
4. As requested by the Owner, during the 1-year warranty period, additional trainings shall take place on the topics as requested by staff. (8 hours)

END OF SECTION 230900

END OF SECTION 23 09 00

SECTION 23 09 93 - SEQUENCE OF OPERATION FOR HVAC CONTROLS

~~SECTION 230993 - SEQUENCE OF OPERATION FOR HVAC CONTROLS~~

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 control sequences for HVAC systems, subsystems, and equipment.

1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.
2. Division 23 Section “Condensing Boilers” for controls components furnished with equipment.
3. Division 23 Section “Modular Air Handling Units” for controls components furnished with equipment.
4. Division 23 Section “Air-Cooled Water Chillers” for controls components furnished with equipment.
5. Division 23 Section “Steam Humidifiers” for controls components furnished with equipment.

1.3 DEFINITIONS

A. CFM: Air flow in cubic feet per minute.

B. CO2: Carbon Dioxide.

C. DDC: Direct digital control.

D. VAV: Variable air volume.

E. VFD: Variable frequency drives.

1.4 HEATING SYSTEM CONTROL SEQUENCES

A. Hot Water Boilers (B-1, B-2 & B-3):

1. Boilers furnished with factory installed and programmed controller. Third party external control is not required to operate and sequence the boilers.
2. All boilers shall be connected via a daisy chain 2-wire communication cable.
3. Boiler controls shall energize associated heating injection pump (P-1, 2 & 3) prior to firing.
4. A 3-way mixing valve serving the heating zones shall modulate to maintain heating water setpoint. Provide a sensor downstream of the mixing valve to reset the hot water supply inversely with outside air. The boilers shall stage and modulate as necessary to achieve the following reset water schedule:
5. Outside air temperature Hot water supply temperature
6. ≤0°F 140°F

7. 60°F 100°F
8. Boilers shall stage and modulate in order to achieve 170 degrees Fahrenheit (76.67 degrees Celsius) supply water setpoint when there is a call for domestic hot water.
9. When heating loop falls below heating setpoint lead boiler shall fire and modulate to maintain loop temperature setpoint.
10. If lead boiler cannot maintain loop setpoint second boiler shall be energized as required and modulate in parallel to maintain setpoint.
11. If two boilers are unable to maintain lop setpoint the third boiler shall be energized as required and modulate in parallel to maintain setpoint.
12. Boilers shall rotate lead boiler to insure equal runtime. If lead boiler fails to fire an alarm shall be generated and the next boiler shall start. Lead boiler shall be evaluated on a monthly basis based on run hours.

B. Control points to be provided and shown on the graphic page are as follows:

1. DDC system graphic.
2. On /off status.
3. Outside air temperature.
4. Outside air humidity.
5. Firing rate.
6. Hot water reset schedule.
7. Hot water loop supply temperature.
8. Boiler supply temperature for each boiler.
9. Boiler return temperature for each boiler.
10. On / off status for boiler pump.
11. Alarm status.
12. Button on graphic page to open sequence of operation.

1.5 HOT WATER PUMP CONTROL SEQUENCES

A. Control of Boiler Injection Pumps (P-1, P-2 & P-3): Provided with boiler controls as noted above.

B. Facility Hot Water Heating Distribution Pumps (P-4 & P-5):

1. Controls integral with boiler shall enable pump.
2. Pump(s) shall operate on in a lead-lag sequence to provide equal runtime.
3. Pump(s) shall vary speed to maintain differential pressure setpoint (as determined during TAB procedure) based on differential pressure sensor field located at 2/3 of the longest pipe run.
4. Differential pressure maintenance: If lead pump fails to maintain differential setpoint, or VFD is above 85% speed (adjustable) enable lag pump and ramp to maintain differential setpoint by operating both pumps in parallel. During parallel pump operation optimize by maintaining and ramping both pumps together at same frequency.
5. As load decreases and both VFDs are running at 35% speed (adjustable) or less, return to single pump operation.
6. Read operating current from VFD to monitor and report status. If either pump fails then the other pump shall start and signal alarm to the DDC System. Provide a dead band in the programming to prevent short cycling.

C. Indirect Fired Domestic Hot Water Zone Pump Control (P-6, P-7):

1. Cycle inline pumps serving domestic water heaters to maintain domestic hot water storage tank temperature set point of 140 degrees Fahrenheit (60 degrees Celsius) during occupied modes. Disable associated boiler water pumps during unoccupied modes.
2. Provide on / off and lead / lag and rotation of pumps. Provide a current sensor for each pump to monitor and report status. If either pump fails then the other pump shall start and signal alarm to the DDC System. Provide a dead band in the programming to prevent short cycling. The respective pumps shall rotate on a monthly basis

D. Control points to be provided and shown on the graphic page are as follows:

1. DDC system graphic.
2. On /off status for each boiler.
3. Boiler injection pump status.
4. Boiler firing rate for each boiler.
5. Outside air temperature.
6. Hot water supply reset schedule.
7. Hot water supply temperature.
8. Hot water return temperature.
9. Domestic hot water storage temperature.
10. Domestic hot water storage temperature set point.
11. Pump status for each pump.
12. VFD frequency and percent for each pump.
13. VFD operating current in amps for each pump.
14. Lead/Lag and rotation schedule for pumps.
15. Pressure differential.
16. Pressure differential setpoint.
17. Alarm status.
18. Button on graphic page to open sequence of operation.

1.6 CHILLED WATER SYSTEM CONTROL SEQUENCES

A. Packaged Chiller (CH-1) specified with factory furnished and installed control package. Refer to Specification Sections 236423 “Scroll Water Chillers”. Coordinate and integrate with building controls system.

B. Stage Chiller Plant to optimize system efficiency by staging compressors and varying the water flow based on facility demand to maintain chilled water setpoint.

1. Prior to chiller starting, associated pump(s) shall start and prove flow through flow switch, supplied by chiller manufacturer, for field installation. Once water flow is confirmed chiller shall start and stage compressors as necessary to maintain system chilled water setpoint.
2. If chiller fails to start an alarm shall be generated at the DDC system.

C. Chilled-Water Supply Temperature Control: System resets chilled-water supply temperature according to highest cooling demand during occupied and unoccupied

periods. Basis of design chilled water supply temperature 44F, reset up to maximum 50F (adjustable) when low demand.

D. Chilled-Water Circulating Pump Control: (P-8 & P-9)

1. Interlock with chiller. System starts pump and proves flow through chiller before allowing chiller to start.
2. Pumps shall have VFD's furnished and installed by Controls Contractor. Provide a differential pressure sensor to control the system pressure by modulating the respective pump. Locate sensor pipe mounted at approximately 2/3 point in piping distribution, (at header serving most remote AHU).

    a. Provide lead / lag and rotation of pumps. The respective pumps shall rotate on a monthly basis.

    b. Differential pressure maintenance: If lead pump fails to maintain differential setpoint, or VFD is above 85% speed (adjustable) enable lag pump and ramp to maintain differential setpoint by operating both pumps in parallel. During parallel pump operation optimize by maintaining and ramping both pumps together at same frequency.

    c. As load decreases and both VFDs are running at 35% speed (adjustable) or less, return to single pump operation.

    d. Read operating current from VFD to monitor and report status. If either pump fails then the other pump shall start and signal alarm to the DDC System. Provide a dead band in the programming to prevent short cycling.

E. Control points to be provided and shown on the graphic page are as follows:

1. DDC system graphic, include button with the Sequence of Operation text.
2. Outside air temperature.
3. Outside air humidity.
4. Chiller status (on/off).
5. Chiller % load.
6. Chilled water supply schedule.
7. Chilled water supply temperature.
8. Chilled water return temperature.
9. On / off status for each pump.
10. VFD frequency and percent for each pump.
11. VFD operating current in amps for each pump.
12. Differential pressure (setpoint).
13. Differential pressure (measured).
14. Lead/Lag and rotation schedule.
15. Common trouble alarm from Packaged Chiller factory furnished control package.
16. Alarm status.
17. Alarm codes, include button with manufacturer's reference trouble codes.
18. Button on graphic page to open sequence of operation.

F. Control points from the chiller factory controls to be displayed on the graphics page for monitoring purposes:

1. Evaporator entering water temperature.
2. Evaporator leaving water temperature.
3. Leaving water temperature reset.
4. Evaporator flow switch status.
5. Solenoid valve position, for each circuit.
6. Suction temperature, for each circuit.
7. Compressor status of each compressor.
8. Condenser fan status of each fan.

1.7 VAV AIR HANDLING UNIT CONTROL SEQUENCE (AHU-1)

A. Air handling system shall start through DDC system provided all safeties have been satisfied.

B. Occupied: System commands supply and exhaust fans to run continuously.

C. Optimum Start: Unit shall start prior to the programmed occupied period in a warm-up/cool-down sequence (with outside air dampers closed) in order to achieve occupied space temperature for the start of the occupied period.

D. Fan Control: Motor operated dampers on the outside air and exhaust air louvers shall prove 100% open prior to fan start. When the fan starts during the occupied mode the outside air, return air, and exhaust air dampers within the air handler shall open to their minimum positions. The respective VFD's on the supply and return fans shall provide for a soft start and ramp to maintain duct static pressure setpoints (adjustable). Supply duct static pressure sensor shall be located in the associated duct system at 2/3 of the furthest run. The return fan(s) shall modulate speed to maintain positive space pressure. See space pressurization below. In spaces with wall mounted CO2 sensors the VAV terminal units modulate to maintain CO2 setpoint in each space. Refer to terminal unit control sequences. If CO2 is not satisfied after a period of 5 minutes with VAV at maximum, outdoor air damper shall modulate open past minimum until CO2 setpoint is satisfied.

1. If fan status is 'on' but fan airflow sensor records no airflow, an alarm shall be generated.
2. Each fan shall have inlet air flow measuring stations for monitoring.

E. Outdoor Airflow Monitoring: Air handling units scheduled and specified furnished with factory installed airflow outdoor airflow measuring stations. System shall continually monitor outdoor airflow and signal alarm to the DDC system if less than scheduled minimum.

F. Stop Mode: The supply fan and return fans will be off, the outside air damper will be closed, and the heating valve will be fully closed.

G. Smoke detection: Stop fans, and return system to STOP mode upon a signal from the fire alarm system. Wiring from the fire alarm device to the motor starters provided under Division 26. Provide status of each fan and alarm the DDC system if a fan fails to start.

H. Freeze Protection: Provide a manual reset freeze stat across the heating coil to stop the fan, close the outside air damper, fully open heating control valve, and alarm the DDC

system if the freeze stat trips. Freeze stat setpoint at 38 degrees Fahrenheit (3.33 degrees Celsius).

I. Supply Air Temperature Control: During occupied periods system modulates the chilled water control valve, and hot water control valve to maintain supply air temperature occupied setpoint. During morning warm up supply air temperature shall be increased to achieve room setpoint. During unoccupied periods maintain unoccupied set-point. A mixed air sensor located in the mixing box, averaging type, shall monitor the mixed air temperature. Provide supply air reset based on outside air temperature as follows:

1. At outdoor temperatures of 70 degrees Fahrenheit (21.11 degrees Celsius) or greater provide 55 degrees Fahrenheit (12.78 degrees Celsius) supply air (adjustable).
2. At outdoor temperatures of 0 degrees Fahrenheit (-17.78 degrees Celsius) or less provide 62 degrees Fahrenheit (16.67 degrees Celsius) supply air (adjustable).
3. Reset cooling supply linearly between the two points.

J. Economizer: On a call for cooling, if the enthalpy of the outside air is less than the enthalpy of the return air the outside air dampers shall modulate past minimum position up to 100% open to permit “free cooling” with outside air. Return air damper shall modulate inversely with the outside air damper position down to 100% closed. Mechanical cooling shall operate only to supplement economizer operation and to meet discharge air setpoint when the AHU is in economizer cooling.

1. During economizer operation, mixed air temperature sensor shall provide a low temperature limit set at 53 degrees Fahrenheit (11.67 degrees Celsius) to prevent over cooling/reheating. If temperature drops below setpoint, outside air dampers shall close until setpoint is maintained.
2. During normal operation at minimum fan speeds, and when demand control is active, it is acceptable for the mixed air temperature to be below this setpoint.

K. Primary Humidification Control: Humidification shall be energized when building return air is below 50 deg wb (adjustable). Modulate steam valve and cycle steam generator to maintain humidity setpoint.

L. Building Pressurization:

1. On the AHU-1 graphics page provide a table displaying outside air volume, and sum of exhaust air from AHU-1 (provide airflow measuring), and EF-1. Display calculated differential building airflow (with + or – indication ahead of number).
2. Display Hospital building differential pressure reading from wall mounted pressure sensor in reference to outdoor pressure sensor.
3. Adjust AHU-1 outside air damper and return fan speed as necessary to maintain pressure setpoint of 0.005 inch (0.13 mm)-wc (adjustable).

M. Control points to be provided and shown on the graphic page are as follows:

1. DDC system graphic.
2. DDC system on-off indication.
3. DDC system occupied/unoccupied mode.
4. Unoccupied override status.
5. Damper position of each damper.

6. Outdoor airflow setpoint, minimum, and actual measured, CFM.
7. Outdoor-air-temperature indication.
8. Supply-air-temperature.
9. Supply-air-temperature setpoint.
10. Return air-temperature.
11. Return air humidity.
12. Return air humidity setpoint.
13. Exhaust air airflow, CFM.
14. Sum of building exhaust airflow, CFM.
15. Building differential airflow, CFM.
16. Building pressure, in-wc.
17. Building pressure target.
18. Humidifier control valve position.
19. Humidifier steam generator status.
20. Mixed air temperature.
21. Mixed air temperature low limit setpoint.
22. Hot water valve position.
23. Hot water supply temperature.
24. Hot water return temperature.
25. Hot water coil leaving air temperature.
26. Chilled water valve position.
27. Chilled water supply temperature.
28. Chilled water return temperature.
29. Chilled water coil leaving air temperature.
30. Supply fan status, for each fan.
31. VFD frequency, for each fan.
32. Supply fan airflow, for each fan.
33. Return fan status, for each fan.
34. VFD frequency, for each fan.
35. Return fan airflow, for each fan.
36. Smoke detection alarm.
37. Freeze protection alarm.
38. Fan alarm.
39. Button on graphic page to open sequence of operation.

1.8 TERMINAL UNIT CONTROL SEQUENCES

A. Variable Air Volume (VAV) Terminal Units

1. VAV terminal units shall follow an occupied/unoccupied schedule as set in the DDC system.
2. During the occupied period the VAV damper shall open to its minimum position to provide the required volume of ventilation air. A wall mounted thermostat shall modulate terminal unit damper to maintain space temperature cooling setpoint 76 degrees Fahrenheit (24.44 degrees Celsius), adjustable). On rise of space temperature above the cooling setpoint modulate terminal unit up to its maximum airflow. As space temperature drops below the cooling setpoint modulate terminal unit to its minimum airflow.

3. When the space temperature falls below the heating setpoint 70 degrees Fahrenheit (21.11 degrees Celsius), adjustable), modulate the terminal unit damper to the heating position and modulate the reheat coil control valve to maintain heating setpoint.
4. If CO2 levels rise above setpoint (900ppm, adjustable), the VAV damper shall modulate between the minimum and maximum position to maintain setpoint. If damper is at maximum position, and CO2 level has not dropped below setpoint for a period of 5 minutes, signal associated air handler to modulate outside air dampers open.
5. During the unoccupied period the terminal unit damper shall return to a closed position. Damper shall cycle to maintain unoccupied setpoints 64 degrees Fahrenheit (17.78 degrees Celsius), heating and 80 degrees Fahrenheit (26.67 degrees Celsius), cooling, adjustable).
6. Provide manual override (unoccupied to occupied modes) at the wall mounted thermostat. Space will maintain occupied setpoints for a period of 1 hour (adjustable).
7. Control points to be provided and shown on the graphic page are as follows:
    a. System graphic.
    b. Space/area served.
    c. Space temperature.
    d. Occupied / unoccupied status.
    e. Airflow for each unit (CFM).
    f. Terminal unit damper position.
    g. Space CO2 level indication.
    h. Space CO2 setpoint.
    i. Hot water valve position.
    j. Discharge air temperature.
    k. Button on graphic page to open sequence of operation.

B. Unit Heaters:

1. A space sensor shall open the control valve and cycle the fan subject to an aquastat on the hot water return pipe sensing that there is hot water available.
2. Cycle unit heater to maintain heating setpoint of 64 degrees Fahrenheit (17.78 degrees Celsius).
3. Provide current sensor to prove fan operation.
4. Control points to be provided and shown on the graphic page are as follows:
    a. DDC System table.
    b. Space temperature.
    c. Space temperature setpoint.

d. Fan status.

C. Cabinet Unit Heaters:

1. A space sensor shall open the control valve and cycle the fan subject to an aquastat on the hot water return pipe sensing that there is hot water available.
2. Cycle unit heater to maintain heating setpoint of 66 degrees Fahrenheit (18.89 degrees Celsius).
3. Air curtain units shall start fan when door switch indicates door is open. Heating valve position shall depend on space temperature. Unit shall also cycle fan and open heating valve to heat space without door indication.
4. Provide current sensor to prove fan operation.
5. Control points to be provided and shown on the graphic page are as follows:

a. DDC System table.

b. Space temperature.

c. Space temperature setpoint.

d. Fan status.

e. Door indication (air curtain units only)

D. Finned-Tube Radiators:

1. A wall mounted sensor opens the control valve to maintain the occupied space temperature heating set point 70 degrees Fahrenheit (21.11 degrees Celsius), adjustable). Unoccupied periods maintain heating setpoint (64 degrees Fahrenheit (17.78 degrees Celsius), adjustable).
2. Where finned-tube radiation is part of a zone served by a VAV, the hot water control valve shall open when the VAV coil hot water control valve is open to 25% (adjustable) or greater.
3. Control points to be provided and shown on the graphic page are as follows:

a. DDC System Graphic, include button with the Sequence of Operation text.

b. Space temperature and set point.

c. Valve commanded position.

E. Ceiling Radiant Panels:

1. A wall space sensor shall open the control valve to maintain setpoint.
2. Cycle hot water control valve to maintain heating setpoint of 70 degrees Fahrenheit (21.11 degrees Celsius).
3. Control points to be provided and shown on the graphic page are as follows:

a. DDC System table.

b. Space temperature.

c. Space temperature setpoint.

1.9 MINI-SPLIT AIR CONDITIONER SEQUENCE (EVU-X & ACCU-X)

A. Mini-split air conditioning systems shall be provided with factory controls, see Division 23 “Mini-split Air Conditioners” for controls components furnished with equipment.

B. On a call for cooling the condensing unit shall start provided all safeties are satisfied. Condensing unit shall cycle compressors and/or vary evaporator fan speed as needed to satisfy the load.

C. Indoor evaporators shall operate as follows:

1. Wall mounted space thermostat shall cycle and/or modulate indoor evaporator to maintain space temperature cooling setpoint of 78 degrees Fahrenheit (25.56 degrees Celsius).
2. Where applicable, spaces served by multiple evaporators the second evaporator cooling setpoint shall be set 2 degrees Fahrenheit (-16.67 degrees Celsius) above the lead.
3. A DDC space temperature sensor shall provide monitoring of space temperature. Provide alarm if space temperature is 4 degrees Fahrenheit (-15.56 degrees Celsius) above setpoint.
4. Current sensors installed on condensing unit circuits shall provide status feedback.

D. Control points to be provided and shown on the graphic page are as follows:

1. DDC system graphic.
2. Outside air temperature.
3. Space temperature.
4. Space temperature setpoint.
5. Condensing unit status.

1.10 GENERAL EXHAUST CONROL SEQUENCES

A. General Building Exhaust (EF-1)

1. Exhaust fan shall run continuously.
2. Provide current sensor to provide status feedback.
3. Provide airflow measuring probe in the exhaust airstream for monitoring.
4. Control points to be provided and shown on the graphic page are as follows:

a. Fan status.

b. Exhaust airflow measured.

c. Exhaust airflow setpoint.

1.11 PLUMBING EQUIMPMENT CONTROL AND MONITORING SEQUENCES

A. Domestic Water Heaters (DWH-1 & DWH-2):

1. Water heaters shall produce 140 degrees Fahrenheit (60 degrees Celsius) domestic hot water.
2. Provide sensors to monitor both the storage temperature of each water heater and the distribution system temperature leaving the mixing valve.

3. If water heater storage temperature falls below 135 degrees Fahrenheit (57.22 degrees Celsius) provide an alarm.
4. If distribution temperature falls below 115 degrees Fahrenheit (46.11 degrees Celsius) provide an alarm.
5. Control points to be provided and shown on the graphic page are as follows:
    a. Water heater storage tank temperature, for each tank.
    b. Distribution system temperature.
    c. Alarm Status.

B. Domestic Hot Water Recirculation Pump (HWRP-1):

1. A domestic hot water return sensor shall enable the pump whenever the domestic hot water is below 120 F (adjustable set-point).
2. Control points to be provided and shown on the graphic page are as follows:
    a. Pump Status.
    b. Alarm Status.

C. Blood Draw Toilet Room Domestic Water Shut Off:

1. Wall switch in Blood Draw shall interrupt power to motorized valves in domestic hot and cold water branches serving adjacent toilet room. When power is interrupted to valves, valves shall spring closed.
2. When wall switch returns to ‘on’ position, power shall be restored to valves and valves shall motor open.
3. Clearly label wall switch “Domestic Water Shutoff”.
4. Clearly label ‘open’ and ‘closed’ positions.

D. Medical Air Compressor (MCA-1):

1. Provide the following monitoring points from the Medical Air skid control panel:
    a. System trouble or malfunction alarm
    b. High dew point alarm.
    c. High carbon monoxide alarm.
    d. Main line pressure high alert.
    e. Main line pressure low alert.
    f. Standby pump operation (lead pump alarm)

E. Medical Vacuum (MVAC-1):

1. Provide the following monitoring points from the Medical Vacuum skid control panel:
    a. System trouble or malfunction alarm.
    b. Low vacuum alarm.

c. Standby pump operation (lead pump alarm)

F. Medical Oxygen Manifold (MOXY-1):

1. Provide the following monitoring points from the Oxygen Manifold control panel:

a. Changeover status.

b. Main line pressure low alert.

c. Main line pressure high alert.

1.12 EMERGENCY POWER INTEGRATION

A. Upon loss of normal power, only Life Safety mechanical equipment and select mechanical equipment shall continue to operate per indicated sequence of operation. Upon restart on emergency power, major mechanical equipment shall restart at 30 second intervals to avoid large current draw on generator. Restart schedule per below:

1. Mini-split air conditioners.
2. Boiler plant and all associated pumps.
3. AHU-1.
4. Chilled water plant and associated pumps.
5. Remainder of equipment.

B. Upon restoration of normal power, mechanical equipment including fans, pumps and compressors shall restart provided all safeties have been satisfied, based on last controlling state, or resume indicated sequence of operation. A minimum (adjustable) 15 second time-delay between major equipment per above list shall be provided.

1.13 MONITORING

A. In addition to the points indicated in this section for specific equipment sequences and operation, provide Monitoring and Logging of Mechanical & Electrical Systems, per Division 23 Section “Instrumentation and Control for HVAC”.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

3.1 END OF SECTION 230993

END OF SECTION 23 09 93

SECTION 23 11 26 - FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for propane gas piping systems.

1.2 RELATED REQUIREMENTS

A. Section 08 31 00 - Access Doors and Panels.

B. Section 09 91 13 - Exterior Painting.

C. Section 09 91 23 - Interior Painting.

D. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.

E. Section 23 05 53 - Identification for HVAC Piping and Equipment.

1.3 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B31.1 - Power Piping; 2024.

C. ASME B31.9 - Building Services Piping; 2025.

D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.

F. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

G. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.

H. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

I. NFPA 58 - Liquefied Petroleum Gas Code; 2024, with Amendment.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. 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 PROPANE GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
2. Joints: NFPA 58, threaded or welded to ASME B31.1.

2.2 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches (80 mm) and Under:

1. Ferrous Pipe: Class 150 malleable iron threaded unions.

B. Flanges for Pipe Size Over 1 Inch (25 mm):

1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

2.3 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.
5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.

2.4 BALL VALVES

A. Construction, 4 Inches (100 mm) and Smaller: MSS SP-110, Class 150, 400 psi (2760 kPa) CWP, brass, bronze, or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, Teflon seats and stuffing box ring, blowout proof stem, lever handle with balancing stops, solder, threaded, or grooved ends with union.

B. Valves must be listed for propane gas service per NFPA 58.

2.5 PLUG VALVES

A. Construction 2-1/2 Inches (65 mm) and Larger: MSS SP-78, 175 psi (1200 kPa) CWP, cast iron body and plug, pressure lubricated, Teflon or Buna N packing, flanged ~~or grooved~~ threaded ends. Provide lever operator with set screw.

2.6 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

A. Manufacturers:

1. Actaris Metering Systems (A brand of ITT Controls); _____: www.actaris-metering-systems.com/#sle.
2. Maxitrol Company; _____: www.maxitrol.com/#sle.

B. Materials in Contact With Gas:

1. Housing: Aluminum, steel (free of non-ferrous metals).
2. Seals and Diaphragms: NBR-based rubber.

C. Maximum Inlet Operating Pressure: 10 psi (68.9 kPa).

1. Appliance Regulator: 10 psi (68.9 kPa).
2. Line Pressure Regulator: 10 psi (68.9 kPa).

D. Maximum Body Pressure: 10 psi (1000 mbar).

E. Output Pressure Range: 1 inch wc (2.5 mbar) to 80 inch wc (200 mbar).

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 in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 23 05 16.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

H. Provide access where valves and fittings are not exposed.

1. Coordinate size and location of access doors with Section 08 31 00.

I. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

1. Painting of interior plumbing systems and components is specified in Section 09 91 23.
2. Painting of exterior plumbing systems and components is specified in Section 09 91 13.

J. Install valves with stems upright or horizontal, not inverted.

K. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.

L. Sleeve pipes passing through partitions, walls and floors.

M. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9.
2. Support horizontal piping as indicated.
3. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
5. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

a. Painting of interior plumbing systems and components is specified in Section 09 91 23.

3.3 APPLICATION

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

B. Provide plug valves in natural gas systems for shut-off service.

3.4 SCHEDULES

A. Pipe Hanger Spacing:

1. Metal Piping:

a. Pipe Size: 1/2 inches (15 mm) to 1-1/4 inches (32 mm):

1) Maximum Hanger Spacing: 6.5 ft (2 m).

2) Hanger Rod Diameter: 3/8 inches (9 mm).

b. Pipe size: 1-1/2 inches (40 mm) to 2 inches (50 mm):

1) Maximum Hanger Spacing: 10 ft (3 m).
2) Hanger Rod Diameter: 3/8 inch (9 mm).

c. Pipe size: 2-1/2 inches (65 mm) to 3 inches (75 mm):

1) Maximum Hanger Spacing: 10 ft (3 m).
2) Hanger Rod Diameter: 1/2 inch (13 mm).

END OF SECTION 23 11 26

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hydronic system requirements.

B. Heating water piping, above grade.

C. Heating water and glycol piping, above grade.

D. Chilled water piping, above grade.

E. Pipe hangers and supports.

F. Unions, flanges, mechanical couplings, and dielectric connections.

G. Valves:

1. Ball valves.
2. Butterfly valves.
3. Check valves.

1.2 RELATED REQUIREMENTS

A. Section 08 31 00 - Access Doors and Panels.

B. Section 23 05 23 - General-Duty Valves for HVAC Piping.

C. Section 23 07 19 - HVAC Piping Insulation.

D. Section 23 21 14 - Hydronic Specialties.

E. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.3 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

D. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings; 2021.

E. ASME B31.9 - Building Services Piping; 2025.

F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.

H. ASTM B32 - Standard Specification for Solder Metal; 2020.

I. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

J. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

K. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.

L. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).

M. ASTM F3226/F3226M - Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems; 2019 (Reapproved 2024).

N. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

O. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe; 2000.

P. AWWA C606 - Grooved and Shouldered Joints; 2022.

Q. IAPMO (UMC) - 2024 Uniform Mechanical Code; 2024.

R. IAPMO/ANSI/CAN Z1117 - Standard for Press Connections; 2022.

S. ICC (IMC) - International Mechanical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

T. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data:

1. Include data on pipe materials, pipe fittings, valves, and accessories.
2. Provide manufacturers catalog information.
3. Indicate valve data and ratings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. 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 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:

1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Grooved mechanical joints may be used in accessible locations only.
    a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
    b. Use rigid joints unless otherwise indicated.
4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated:

1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch (20 mm) gate valves with cap; pipe to nearest floor drain.
2. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.
3. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.

2.2 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:

1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
4. Mechanical Press Sealed Fittings: ASTM F3226/F3226M, ICC (IMC), and IAPMO (UMC) approved, with EPDM seals.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (Type B), drawn temper, using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
    a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
    b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
2. Mechanical Press Sealed Fittings: ASME B16.51 or IAPMO/ANSI/CAN Z1117, ICC (IMC), and IAPMO (UMC) approved, with EPDM seals.

a. Manufacturers:

1) Apollo Valves; _____: www.apollovalves.com/#sle.

2) Mueller Streamline, Co; PRS: www.muellerstreamline.com/#sle.

3) _____.

2.3 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:

1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
4. Mechanical Press Sealed Fittings: ASTM F3226/F3226M, ICC (IMC), and IAPMO (UMC) approved, with EPDM seals.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (Type B), drawn temper.

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.

a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.

2. Mechanical Press Sealed Fittings: ASME B16.51 or IAPMO/ANSI/CAN Z1117, ICC (IMC), and IAPMO (UMC) approved, with EPDM seals.

a. Manufacturers:

1) Apollo Valves; _____: www.apollovalves.com/#sle.

2) Mueller Streamline, Co; PRS: www.muellerstreamline.com/#sle.

3) _____.

2.4 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Greater: 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 6 Inches (150 mm) and Greater: Adjustable steel yoke, cast iron roll, double hanger.

6. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.5 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe of 2 Inches (50 mm, DN) and Less:

1. Ferrous Piping: 150 psi (1034 kPa) brass or malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches (50 mm, DN) and Greater:

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.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.

1. Dimensions and Testing: In accordance with AWWA C606.
2. Mechanical Couplings: Comply with ASTM F1476.
3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

D. Dielectric Connections:

1. Waterways:

a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.

b. Dry insulation barrier able to withstand 600-volt breakdown test.

c. Construct of galvanized steel with threaded end connections to match connecting piping.

d. Suitable for the required operating pressures and temperatures.

2. Flanges:

a. Dielectric flanges with same pressure ratings as standard flanges.

b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.

c. Dry insulation barrier able to withstand 600-volt breakdown test.

d. Construct of galvanized steel with threaded end connections to match connecting piping.

e. Suitable for the required operating pressures and temperatures.

3. Unions:

a. 1/2 to 1 Inches (15 to 25 mm): Brass solder to galvanized FPT.

b. 1/2 to 2 Inches (15 to 50 mm): Brass solder to galvanized FPT.

c. 1/2 to 1 Inches (15 to 25 mm): Brass to galvanized FPT or FIP (Female Iron Pipe).

d. 3/4 to 1/2 Inch (20 to 15 mm) Reducer: Brass solder to galvanized FPT.

e. Service: 250 psi (1,723.6 kPa), minus 20 to 180 deg F (minus 28.9 to 82.2 deg F).

2.6 BALL VALVES

A. Up To and Including 2 Inches (50 mm):

1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

B. Over 2 Inches (50 mm):

1. Ductile iron body, chrome plated stainless steel ball, teflon, Virgin TFE, or _____ seat and stuffing box seals, lever handle, gear operated, or _____, flanged ends, rated to 800 psi (5515 kPa).

2.7 BUTTERFLY VALVES

A. Body: Cast or ductile iron with resilient replaceable EPDM seat, ~~wafer, lug, grooved, or [____]~~wafer or lug ends, extended neck.

B. Disc: Construct of ~~aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, Buna-N encapsulation, or [____]~~aluminum bronze, chrome plated ductile iron, or stainless steel.

C. Stem: Stainless steel with stem offset from the centerline to provide full 360-degree circumferential setting.

D. Operator: 10 position lever handle.

2.8 SWING CHECK VALVES

A. Up To and Including 2 Inches (50 mm):

1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.

B. Over 2 Inches (50 mm):

1. Iron body, ~~bronze or [____]~~bronze trim, ~~stainless steel, bronze, bronze faced rotating, or [____]~~stainless steel, bronze, or bronze faced rotating swing disc, renewable disc and seat, ~~flanged, grooved, or [____]~~flanged ends.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems. See Section 23 25 00 for additional requirements.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Route piping in orderly manner, parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and to avoid interference with use of space.

D. Group piping whenever practical at common elevations.

E. Sleeve pipe passing through partitions, walls, and floors.

F. Slope piping and arrange to drain at low points.

G. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2-inch (13 mm) space between finished covering and adjacent work.
4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
5. Use hangers with 1-1/2 inches (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. See Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 07 19.

I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00 .

J. Install valves with stems upright or horizontal, not inverted.

3.3 SCHEDULES

A. Hanger Spacing for Copper Tubing.

1. 1/2 Inch (15 mm) and 3/4 inch (20 mm): Maximum span, 5 feet (1500 mm); minimum rod size, 1/4 inch (6 mm).
2. 1 Inch (25 mm): Maximum span, 6 feet (1800 mm); minimum rod size, 1/4 inch (6 mm).
3. 1-1/2 Inches (40 mm) and 2 Inches (50 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).
4. 2-1/2 Inches (65 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9 mm).
5. 3 Inches (80 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9 mm).
6. 4 Inches (100 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 1/2 inch (13 mm).

B. Hanger Spacing for Steel Piping.

1. 1/2 Inch (15 mm), 3/4 Inch (20 mm), and 1 Inch (25 mm): Maximum span, 7 feet (2100 mm); minimum rod size, 1/4 inch (6 mm).
2. 1-1/4 Inches (32 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).
3. 1-1/2 Inches (40 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9 mm).
4. 2 Inches (50 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9 mm).
5. 2-1/2 Inches (65 mm): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9 mm).
6. 3 Inches (80 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 3/8 inch (9 mm).
7. 4 Inches (100 mm): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).

END OF SECTION 23 21 13

SECTION 23 21 14 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Compression tanks.

B. Expansion tanks.

C. Air vents.

D. Air separators.

E. Strainers.

F. Pump connectors.

G. Balancing valves.

H. Relief valves.

I. Glycol system.

1.2 RELATED REQUIREMENTS

A. Section 22 11 19 - Domestic Water Piping Specialties: Backflow preventers.

B. Section 23 21 13 - Hydronic Piping.

C. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.3 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for 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 and model.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. 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 EXPANSION TANKS

A. Manufacturers:

1. Amtrol Inc; _____: www.amtrol.com/#sle.
2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
3. Taco, Inc; _____: www.taco-hvac.com/#sle.

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi (80 kPa), and steel support stand.

C. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced-pressure-principle backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

1. See Section 22 11 19 for backflow preventer specifications.

2.2 AIR VENTS

A. Manual Air Vent: Short vertical sections of 2-inch (50 mm, DN) diameter pipe to form air chamber, with 1/8 inch (6 mm, DN) brass needle valve at top of chamber.

B. Float Air Vent:

1. 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.

C. Maximum Fluid Pressure: 150 psi (1,034 kPa).

D. Maximum Fluid Temperature: 250 degrees F (121.1 degrees C).

2.3 AIR SEPARATORS

A. Coalescing Air/Dirt Separators:

1. Manufacturers:

a. Spirotherm, Inc; _____: www.spirotherm.com/#sle.

2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1 for maximum fluid service subject to application requirements and manufacturer's standard maximum operating conditions.
3. Coalescing Medium: Provide ~~structured copper or stainless steel~~stainless steelperforated and formed pall rings shall ~~medium fill~~ing the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location. Pall rings shall be contained by a stainless steel mess basket.

4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi (1,034 kPa), threaded to top of separator.
5. End Connections: Class 150 flanged for 2-1/2 inch (65 mm, DN) and larger, otherwise threaded.
6. Blowdown Connection: Threaded.
7. Size: ~~Match system flow capacity.~~ As Scheduled on the Drawings.
8. Maximum Fluid Service Pressure: 150 psi (1,034 kPa).
9. Maximum Fluid Service Temperature: 250 degrees F (121.1 degrees C).

2.4 STRAINERS

A. Size 2 inch (50 mm, DN) and Under:

1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi (1,200 kPa) working pressure, Y-pattern strainer with 1/32 inch (0.8 mm) stainless steel perforated screen.

B. Size 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN):

1. Provide flanged or grooved iron body for up to 175 psi (1,200 kPa) working pressure, up to 250 degrees F (121.1 degrees C) working temperature, Y-pattern strainer with 1/16 inch (1.6 mm) or 3/64 inch (1.2 mm) stainless steel perforated screen.

2.5 PUMP CONNECTORS

A. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.

1. Maximum Operating Service: 150 psi (1030 kPa) at 120 degrees F (49 degrees C).
2. Accommodate the Following:
   a. Axial Deflection in Compression and Expansion: _____ inch (_____ mm).
   b. Lateral Movement: ~~[_____] inch ([_____] mm)~~1/2 inch (_____ mm).
   c. Angular Rotation: 15 degrees.
   d. Force developed by 1.5 times specified maximum allowable operating pressure.
3. End Connections: Same as specified for pipe jointing.
4. Provide necessary accessories including, but not limited to, swivel joints.

2.6 BALANCING VALVES

A. Manufacturers:

1. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
2. Taco, Inc; _____: www.taco-hvac.com/#sle.

B. Size 2 inch (50 mm, DN) and Smaller:

1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and female sweat, NPT threaded, press, or soldered connections.
2. Metal construction materials consist of bronze, brass, or _____.

3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or _____.

C. Size 2-1/2 inch (65 mm, DN) and Larger:

1. Provide ball, globe, or butterfly style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged, grooved, or weld-end connections.
2. Valve body construction materials consist of cast iron, carbon steel, ductile iron, or _____.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin, or _____.

2.7 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.8 GLYCOL SYSTEM

A. Pump System:

1. Storage: 15 gal (56.7 L) polypropylene tank with bolt-removable hinged solid cover and enamel coated carbon steel tank-stand.
2. Pump:

a. Thermally protected 1/4 hp (0.2 kW) motor at 115 to 120 VAC, single phase rated for indoor service.

b. Maximum Service Operation: 100 psi (689 kPa) at 85 degrees F (29 degrees C).

3. Mechanical Accessories: System isolation valves, strainer, and pressure gauges.
4. Control Panel:

a. Fused single-point system connection rated at 115 to 120 VAC, single phase.

b. Interface: Hand switches with indicating lights for ON, FAULT, and LOW LEVEL.

c. Pressure Switch: Panel-mounted and prewired for 10 psi (69 kPa) cut-in and 40 psi (276 kPa) cut-out, adjustable.

d. Low Level Cut-Off Switch: Prewired to shut-down unit upon activation. Tank-side mounted.

5. Pressure Relief Valve: System-mounted brass valve tubed from pump discharge side into tank with adjustable setpoint between 20 psi (138 kPa) and 150 psi (1,034 kPa).

B. Glycol Solution:

1. Water-based solution mix containing ~~30~~ ____ percent ethylene glycol by volume required for cooling or heating system operating temperature range.
2. Cooling or heating System Operating Temperature Range: Between freezing and boiling points of ~~3 and 220 degees F (minus 16.1 and 104.4 degees C)~~-7 degrees F (____ degrees C) at 14.7 psia (101.4 kPa).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install specialties and equipment in accordance with manufacturer's instructions.

B. Provide manual air vents at system high points and as indicated.

C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

D. Provide air separator on suction side of system circulation pump and connect to expansion tank.

E. Provide valved drain and hose connection on strainer blowdown connection.

F. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

G. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

H. Pipe relief valve outlet to nearest floor drain.

I. Clean and flush glycol system before adding glycol solution, see Section 23 25 00.

J. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

K. Perform tests determining strength of glycol and water solution and submit written test results.

3.2 MAINTENANCE

A. See Section 01 70 00 - Execution Requirements for additional requirements relating to maintenance service.

B. Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.

C. Perform monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Report findings in detail in writing, including analysis and amounts of glycol or water added.

D. Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION 23 21 14

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. System-lubricated circulators.

B. In-line pumps.

1.2 RELATED REQUIREMENTS

A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

B. Section 23 09 23 - Direct-Digital Control System for HVAC.

C. Section 23 09 34 - Variable-Frequency Motor Controllers for HVAC.

D. Section 23 21 13 - Hydronic Piping.

E. Section 23 21 14 - Hydronic Specialties.

F. Section 25 35 00 - Integrated Automation Instrumentation and Terminal Devices for HVAC.

G. Section 26 29 13 - Enclosed Controllers.

1.3 REFERENCE STANDARDS

A. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks--Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; 2024, with Amendment (2025).

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for 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. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Bell & Gossett, a Xylem Inc. brand; _____: www.bellgossett.com/#sle.

B. Grundfos Pumps Corporation: www.grundfos.com/us/#sle.

C. _____.

2.2 GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Electrical Requirements:

1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 09 34, except for integral-VFDs.
3. Enclosures: Provide unspecified product(s) required to fit motor:

a. Starter(s) inside enclosed controller as indicated on drawings; see Section 26 29 13.

2.3 SYSTEM-LUBRICATED CIRCULATORS

A. Horizontal shaft, single stage, direct connected with multiple speed wet rotor motor for in-line mounting, for 140 psi (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, multiple speed, with external speed selector.

2.4 IN-LINE PUMPS

A. Closed-Coupled, Single-Stage Pump: Vertical pump with radially- or horizontally-split casing; rated for discharge pressures up to 175 psi (1200 kPa).

B. Casing: Cast iron with seal flush connection, threaded suction, and discharge ports with gauge port and drain plug.

C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.

D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.

E. Electrical:

1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 23 05 13.

2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
3. Integral Controls: (as noted on the drawings):

   a. Variable Frequency Drive (VFD): Factory-fitted and tested with dedicated terminal box for power, instrumentation and related control wiring.

   b. DDC Controller: VFD-integrated or external controller module with visual-tactile interface and minimum of 2 analog inputs, 2 digital inputs, and real-time clock. Provide differential pressure sensor and temperature sensor with thermowell and thermal grease.

   c. BAS, SCADA, or Other Integrated Automation Link: Wi-Fi in accordance with IEEE 802.11.

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 space recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches (102 mm) and over.

D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

E. Provide air cock and drain connection on horizontal pump casings.

F. Provide drains for bases and seals, piped to and discharging into floor drains.

G. Controls: Interface each pump starter or VFD with HVAC controller; see Section 23 09 23.

H. Controls Human-Machine Interface (HMI): HVAC operator terminal; see Section 25 35 00.

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Filter-driers.

1.2 RELATED REQUIREMENTS

A. Section 08 31 00 - Access Doors and Panels.

B. Section 23 07 16 - HVAC Equipment Insulation.

1.3 REFERENCE STANDARDS

A. AHRI 710 (I-P) - Performance Rating of Liquid-Line Driers; 2009.

B. AHRI 711 (SI) - Performance Rating of Liquid-Line Driers; 2009.

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

D. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2024, with Addendum (2025).

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

F. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.

G. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

I. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

J. IAPMO (UMC) - 2024 Uniform Mechanical Code; 2024.

K. ICC (IMC) - International Mechanical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

M. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

D. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure integrity of system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASME B31.5 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, inlet and outlet.
4. Use check valves on compressor discharge.
5. Use check valves on condenser liquid lines on multiple condenser systems.

E. Filter-Driers:

1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
2. Use replaceable core filter-driers in lines of 1/2 inch (13 mm) outside diameter or greater.

2.2 REGULATORY REQUIREMENTS

2.3 PIPING

A. Copper Tube: ASTM B280, Type ACR, H58 hard drawn ~~or O60 soft annealed~~.

1. Fittings: ASME B16.22 wrought copper.
2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
3. Mechanical Press Fittings: UL 207 listed, ICC (IMC) and IAPMO (UMC) approved, with HNBR seals.

B. Preinsulated Refrigerant Piping Linesets:

1. Copper Tube: ASTM B280 Type ACR seamless, anticorrosion pipe; lineset is precoupled to include two joined pipes.
2. Insulation: Polyethelene closed-cell foam; minimum 3/4" thick, preapplied to entire length of both pipes in ~~of~~ lineset. Weather- and UV-resistant for outdoor installation. Maximum flame spread index of 25 and maximum smoke developed index of 50, when tested in accordance with ASTM E84 or UL 723.

C. Pipe Supports and Anchors:

1. Provide hangers and supports complying with MSS SP-58.
    a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support for Pipe Sizes to 3 Inches (75 mm): Cast iron hook.
5. Vertical Support: Steel riser clamp.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
8. 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.

2.4 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) no greater than that allowed by federal code.

B. Refrigerant: R-454B as defined in ASHRAE Std 34.

C. Refrigerant: R-32 as defined in ASHRAE Std 34.

2.5 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or soldered ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F (93 degrees C) and maximum working pressure of 500 psi (3450 kPa).

2.6 VALVES

A. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi (3450 kPa).

2.7 STRAINERS

2.8 FILTER-DRIERS

A. Performance:

1. Flow Capacity - Liquid Line: ____ ton (____ kW), minimum, rated in accordance with AHRI 710 (I-P) (AHRI 711 (SI)).
2. Pressure Drop: 2 psi (14 kPa), maximum, when operating at full connected evaporator capacity.
3. Design Working Pressure: 350 psi (2410 kPa), minimum.

B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.

1. Replaceable Core Type: Steel shell with removable cap.
2. Connections: As specified for applicable pipe type.

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, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.5.
2. Support horizontal piping as indicated.
3. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
6. Provide copper plated hangers and supports for copper piping.

G. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 31 00.

J. Flood piping system with nitrogen when brazing.

K. Insulate piping and equipment.

L. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

M. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

O. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to 200 psi (1380 kPa). Perform final tests at 27 inches (92 kPa) vacuum and 200 psi (1380 kPa) using halide torch. Test to no leakage.

3.4 SCHEDULES

A. Hanger Spacing for Copper Tubing.

1. 1/2 inch (13 mm), 5/8 inch (16 mm), and 7/8 inch (22 mm) OD: Maximum span, 5 feet (1500 mm); minimum rod size, 1/4 inch (6.3 mm).
2. 1-1/8 inch (29 mm) OD: Maximum span, 6 feet (1800 mm); minimum rod size, 1/4 inch (6.3 mm).
3. 1-3/8 inch (35 mm) OD: Maximum span, 7 feet (2100 mm); minimum rod size, 3/8 inch (9.5 mm).

4. 1-5/8 inch (41 mm) OD: Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
5. 2-1/8 inch (54 mm) OD: Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9.5 mm).

END OF SECTION 23 23 00

SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials.

1. System cleaner.
2. Closed system treatment (water).

B. By-pass (pot) feeder.

C. Solution tanks.

D. Glycol.

1.2 RELATED REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Owner furnished treatment equipment.

B. Section 23 21 13 - Hydronic Piping.

C. Section 23 21 14 - Hydronic Specialties.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.

E. 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.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.1 MATERIALS

A. System Cleaner:

1. Manufacturers:
2. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.

3. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyltin oxide, methylene bis (thiocyanate).

B. Closed System Treatment (Water): As needed based on water test.

1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.

2.2 BY-PASS (POT) FEEDER

A. Manufacturers:

1. Griswold Controls; _____: www.griswoldcontrols.com/#sle.
2. J. L. Wingert Company; _____: www.jlwingert.com/#sle.
3. Neptune, a brand of the Dover Company; _____: www.neptune1.com/#sle.

B. ~~2 quart (1.9 L)~~6.0 gal (22.7 L) tank with quick opening cap for adding chemicals to closed systems. ~~w~~Working pressure of 175 psi (1200 kPa). Provide drain valve, fill cup and system valves.

2.3 SOLUTION TANKS

A. 30 gallon (114 L) capacity, polyethylene, self-supporting, 1 gallon (3.8 L) graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.

2.4 GLYCOL

A. Description: Glycol-based anti-freeze protection for heat-transfer fluid in hydronic systems; corrosion inhibitors added for prevention of metal piping deterioration.

B. Application: For hydronic heating and cooling or geothermal system.

C. Composition: Use ethylene or nontoxic propylene glycol.

1. Mixture: ~~25 percent~~ ____ by volume mixed into water.

D. Operating Temperature: Rated for operating range of hydronic system.

1. Minimum Mixture Operating Temperature: ~~0 degrees F (minus 17 degrees C)~~ 7 degrees F (____ degrees C).
2. Maximum Mixture Operating Temperature: 215 degrees F (101 degrees C).

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.

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. Chilled Water Systems:

1. Circulate for 48 hours, then drain systems as quickly as possible.
2. Refill with clean water, circulate for 24 hours, then drain.
3. Refill with clean water and repeat until system cleaner is removed.

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.

C. Provide 3/4 inch (19 mm) water coupon rack around circulating pumps with space for 4 test specimens.

3.5 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.

1. Provide minimum of ~~two hours~~one hour of instruction for two people.
2. Have operation and maintenance data prepared and available for review during training.

3. Conduct training using actual equipment after treated system has been put into full operation.

3.6 MAINTENANCE

A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.

B. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.

C. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.

D. 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 two copies of field service report after each visit.

E. Provide laboratory and technical assistance services during this maintenance period.

F. 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.

END OF SECTION 23 25 00

SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal ducts.

B. Flexible ducts.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 09 91 13 - Exterior Painting: Weld priming, weather resistant, paint or coating.

C. Section 09 91 23 - Interior Painting: Weld priming, paint or coating.

D. Section 23 01 30.51 - HVAC Air-Distribution System Cleaning: Post install duct cleaning.

E. Section 23 07 13 - Duct Insulation: External insulation and duct liner.

F. Section 23 33 00 - Air Duct Accessories.

G. Section 23 33 19 - Duct Silencers.

H. Section 23 36 00 - Air Terminal Units.

I. Section 23 37 00 - Air Outlets and Inlets: Fabric air distribution devices.

1.3 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

E. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

G. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for duct materials.

C. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.

1.5 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.

B. Provide metal duct unless otherwise indicated. Fibrous glass duct can be substituted at the Contractor's option.

C. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 23 33 19.

D. Duct Shape and Material in accordance with Allowed Static Pressure Range:

1. Round: Plus or minus 2 in-wc (500 Pa) of galvanized steel.
2. Rectangular: Plus or minus 1/2 in-wc (125 Pa) of galvanized steel.

E. Duct Sealing and Leakage in accordance with Static Pressure Class:

1. Duct Pressure Class and Material for Common Mechanical Ventilation Applications:

a. Supply Air: ~~1/2 in-wc (125 Pa)~~4 in-wc (___ Pa) pressure class, galvanized steel.

b. Outside Air Intake: 1/2 in-wc (125 Pa) pressure class, galvanized steel.

c. Return and Relief Air: ~~1/2 in-wc (125 Pa)~~3 in-wc (___ Pa) pressure class, galvanized steel.

d. General Exhaust Air: 1/2 in-wc (125 Pa) pressure class, galvanized steel.

2. Medium ~~and High~~ Pressure Service: Above 3 in-wc (750 Pa):

a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.

b. Leakage:

1) Rectangular: Class 6 or 6 cfm/100 sq ft (170 Lpm/9.3 sq m).

2) Round: Class 3 or 3 cfm/100 sq ft (85 Lpm/9.3 sq m).

F. Duct Fabrication Requirements:

1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.

3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.2 METAL DUCTS

A. Material Requirements:

1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.

B. Rectangular Metal Duct:

1. Rectangular Single Wall: Rectangular, longitudinal lock seam duct with galvanized steel wall.

C. Flat-Oval Metal Ducts:

1. Flat-Oval Single Wall Duct: Machine made from a round spiral lock seam duct.

a. Fittings: Manufacture at least two gauges heavier metal than the duct.

b. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

D. Round Metal Ducts:

1. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
2. Round Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).

E. Round Spiral Duct:

1. Round spiral lock seam duct with galvanized steel outer wall.

F. Connectors, Fittings, Sealants, and Miscellaneous:

1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.
2. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

a. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.

b. VOC Content: Not more than 250 g/L, excluding water.

c. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.

3. Gasket Tape:

a. Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.

4. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.3 FLEXIBLE DUCTS

A. Flexible Ducts: UL 181, Class 1, polyethylene film, mechanically fastened and rolled using galvanized steel to form spiral helix.

1. Insulation: R6 insulation with polyethylene vapor barrier film.
2. Pressure Rating: 10 in-wc (2.50 kPa) positive and 5 in-wc (1.25 kPa) negative.
3. Maximum Velocity: 5500 fpm (27.9 m/sec).
4. Temperature Range: Minus 20 degrees F to 250 degrees F (Minus 28 degrees C to 121 degrees C).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install products following the manufacturer's instructions.

C. Comply with safety standards NFPA 90A and NFPA 90B.

D. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Flexible Ducts: Connect to metal ducts with adhesive.

G. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.

H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

I. Use double nuts and lock washers on threaded rod supports.

J. Connect terminal units to supply ducts directly or with ~~one foot (300 mm)~~five feet (300 mm) maximum length of flexible duct. ~~Do not use flexible duct to change direction.~~

K. Fire Partitions: Provide firestopping sealing. See Section 07 84 00.

L. Duct Insulation: Provide duct insulation. See Section 23 07 13.

M. Painting: Provide surface finish as indicated on drawings. See Sections 09 91 13 and 09 91 23.

3.2 CLEANING

A. Clean thoroughly each duct system. See Section 23 01 30.51.

B. Clean duct system by forcing air at high velocity through duct to remove accumulated dust. Clean half the system at a time to obtain sufficient air. Protect equipment that could be harmed by excessive dirt with temporary filters or bypass during cleaning.

END OF SECTION 23 31 00

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air turning devices/extractors.

B. Backdraft dampers - metal.

C. Backdraft dampers - fabric.

D. Combination fire and smoke dampers.

E. Duct access doors.

F. Duct test holes.

G. Fire dampers.

H. Flexible duct connectors.

I. Smoke dampers.

J. Volume control dampers.

K. Miscellaneous Products:

1. Duct opening closure film.

1.2 RELATED REQUIREMENTS

A. Section 23 31 00 - HVAC Ducts and Casings.

1.3 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

B. NFPA 92 - Standard for Smoke Control Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

F. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

G. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. 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.

C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.

D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:

1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane): www.carlislehvac.com/#sle.
2. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
3. Ruskin Company; _____: www.ruskin.com/#sle.
4. Titus HVAC, a brand of Johnson Controls; _____: www.titus-hvac.com/#sle.

B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.2 BACKDRAFT DAMPERS - METAL

A. Manufacturers:

1. Nailor Industries, Inc; _____: www.nailor.com/#sle.
2. Ruskin Company; _____: www.ruskin.com/#sle.
3. United Enertech; _____: www.unitedenertech.com/#sle.

B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch (150 mm) width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 BACKDRAFT DAMPERS - FABRIC

A. Fabric Backdraft Dampers: Factory-fabricated.

1. Blades: Neoprene coated fabric material.
2. Birdscreen: 1/2 inch (12 mm) nominal mesh of galvanized steel or aluminum.
3. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

2.5 DUCT ACCESS DOORS

A. Manufacturers:

1. Acudor Products Inc, a Division of Nelson Industrial Inc; _____: www.acudor.com/#sle.
2. Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
3. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
4. Nailor Industries, Inc; _____: www.nailor.com/#sle.
5. Ruskin Company; _____: www.ruskin.com/#sle.
6. SEMCO LLC; _____: www.semcohvac.com/#sle.

B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch (25 mm) thick insulation with sheet metal cover.

1. Less Than 12 inches (300 mm) Square: Secure with sash locks.
2. Up to 18 inches (450 mm) Square: Provide two hinges and two sash locks.
3. Up to 24 by 48 inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.

2.6 DUCT TEST HOLES

A. 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.

2.7 FIRE DAMPERS

A. Manufacturers:

1. ~~Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle~~Greenheck.
2. Nailor Industries, Inc; _____: www.nailor.com/#sle.
3. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
4. Ruskin Company; _____: www.ruskin.com/#sle.
5. United Enertech; _____: www.unitedenertech.com/#sle.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1-inch (250 Pa) pressure-class ducts up to 12 inches (300 mm) in height.

D. Fusible Links: UL 33, separate at 160 degrees F (71 degrees C) with adjustable link straps for combination fire/balancing dampers.

2.8 FLEXIBLE DUCT CONNECTORS

A. Manufacturers:

1. Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
2. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd (1.0 kg/sq m).
2. Metal: 3 inches (75 mm) wide, 24 gauge, 0.0239 inch (0.61 mm) thick galvanized steel.

D. Maximum Installed Length: 14 inch (356 mm).

2.9 SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

B. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by pneumatic actuator.

C. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.10 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
2. Nailor Industries, Inc; _____: www.nailor.com/#sle.
3. Pottorff; _____: www.pottorff.com/#sle.
4. Ruskin Company; _____: www.ruskin.com/#sle.
5. United Enertech; _____: www.unitedenertech.com/#sle.

B. Single Blade Dampers:

1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
2. Blade: 24 gauge, 0.0239 inch (0.61 mm), minimum.

C. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches (200 by 1825 mm). Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.

1. Blade: 18 gauge, 0.0478 inch (1.21 mm), minimum.

D. End Bearings: Except in round ducts 12 inches (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

E. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends.

2.11 MISCELLANEOUS PRODUCTS

A. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.

1. Thickness: 2 mils (0.6 mm).
2. High tack water based adhesive.

3. UV stable light blue color.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 31 00 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch (200 by 200 mm) size access door for hand and shoulder access, or as indicated on drawings. Provide minimum 4 by 4 inch (100 by 100 mm) size access door for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide ~~fire dampers, combination fire and smoke dampers, and smoke dampers~~fire dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.

G. Demonstrate re-setting of fire dampers to Owner's representative.

H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

J. 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 two duct widths from duct take-off.

K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 23 33 00

SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Roof exhausters.

B. Roof ventilators.

C. Cabinet exhaust fans.

D. Inline centrifugal fans and blowers.

1.2 RELATED REQUIREMENTS

A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

B. Section 23 05 48 - Vibration and Seismic Controls for HVAC.

C. Section 23 31 00 - HVAC Ducts and Casings.

D. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.

1.3 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.

B. AMCA 99 - Standards Handbook; 2025.

C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Indicate installation instructions.

D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.

B. Loren Cook Company; _____: www.lorencook.com/#sle.

C. PennBarry, Division of Air System Components; _____: www.pennbarry.com/#sle.

D. Twin City Fan & Blower; _____: www.tcf.com/#sle.

2.2 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: Comply with AMCA 204.

B. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.

C. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.

D. Fabrication: Comply with AMCA 99.

E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.3 ROOF EXHAUSTERS

A. Fan Unit: V-belt or direct driven as indicated, 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.

B. Roof Curb: 8 inch (200 mm) high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

C. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

E. Performance Ratings: As indicated on drawings.

2.4 CABINET EXHAUST FANS

A. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resiliently mounted motor, gravity backdraft damper in discharge.

B. Grille: Molded white plastic.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is reached with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Performance Ratings: As indicated on drawings.

2.5 INLINE CENTRIFUGAL FANS AND BLOWERS

A. Centrifugal Fan Unit: V-belt or direct driven, with galvanized steel housing lined with acoustic insulation, resiliently-mounted motor, gravity backdraft damper in discharge.

B. Forward Curved Blower:

1. Direct-driven, resiliently mounted motor, heavy-duty ball bearings, galvanized steel housing for indoor or outdoor service, and removable service panels.
2. Operation: As indicated on drawings.
3. Accessories: Provide ~~filter section, intake hood with bird screen, and MERV-[___]filters~~backdraft damper and external vibration isolator spring.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm gets reached with sheaves set at mid-position; fan shaft with self-aligning prelubricated ball bearings.

D. Performance Ratings: As indicated on drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

D. ~~Hung~~Suspended Cabinet Fans:

1. Install fans with resilient mountings and flexible electrical leads, see Section 23 05 48.
2. Install flexible connections between fan and ductwork; see Section 23 33 00. Ensure metal bands of connectors are parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.

E. Provide sheaves required for final air balance.

F. Install backdraft dampers on inlet to roof and wall exhausters.

G. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION 23 34 23

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single-duct terminal units.

1. Constant-volume units.
2. Variable-volume units.

1.2 RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration and Seismic Controls for HVAC.

B. Section 23 31 00 - HVAC Ducts and Casings.

C. Section 23 33 00 - Air Duct Accessories.

1.3 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).

C. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).

E. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope; 2019.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

G. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2024.

H. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.

PART 2 PRODUCTS

2.1 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-VOLUME UNITS

A. Manufacturers:

1. Johnson Controls, Inc; _____: www.johnsoncontrols.com/#sle.
2. Metalaire, a brand of Metal Industries Inc; _____: www.metalaire.com/#sle.
3. Price Industries; _____: www.priceindustries.com/#sle.
4. Trane Technologies, PLC; _____: www.trane.com/#sle.

B. General:

1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.

C. Unit Casing:

1. Minimum 22 gauge, 0.0299 inch (0.76 mm) galvanized steel.
2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
3. Unit Discharge: Rectangular, with slip-and-drive connections.
4. Acceptable Liners:

   a. ~~3/4 inch (19 mm)~~1/2 inch (____ mm) thick ~~polyurethane~~closed cell foam ~~adhesive complying with UL 181 erosion requirements in accordance with ASHRAE Std 62.1, and having a maximum smoke developed index of 50 for both insulation and adhesive, when tested in accordance with ASTM E84.~~.

   b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

D. Damper Assembly:

1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
3. Incorporate low leak damper blades for tight airflow shutoff.

E. Hot Water Heating Coil:

1. Coil Casing: Minimum 22 gauge, 0.0299 inch (0.76 mm) galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.

   a. Access Door: Gasketed and insulated located ~~on bottom, on top, and downstream of coils~~on bottom.

   b. Right or left coil inlets.

2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.

    a. Fins to be formed in a high heat transfer sine wave configuration.

3. Coil leak tested to minimum 350 psig (2413 kPa).
4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.

F. Controls:

1. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.

    a. Signal accuracy: Plus/minus five percent throughout terminal operating range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that conditions are suitable for installation.

B. Verify that field measurements are as indicated on drawings.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of ~~four~~three duct diameters from elbows, transitions, and duct takeoffs.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 0548.

E. Do not support from ductwork.

F. Connect to ductwork in accordance with Section 23 31 00.

3.3 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

END OF SECTION 23 36 00

SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Rectangular ceiling diffusers.

B. Ceiling slot diffusers.

C. Ceiling exhaust and return registers/grilles.

D. Ceiling egg crate exhaust and return grilles.

E. Fabric air distribution devices.

F. Louvers.

1.2 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.3 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

D. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

E. UL 2518 - Standard for Safety Air Dispersion Systems; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for 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 showing type, size, location, application, and noise level.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.

B. Metalaire, a brand of Metal Industries Inc; _____: www.metalaire.com/#sle.

C. Price Industries; _____: www.priceindustries.com/#sle.

D. Tuttle and Bailey; _____: www.tuttleandbailey.com/#sle.

2.2 RECTANGULAR CEILING DIFFUSERS

A. Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.

B. Connections: Round.

C. Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.

D. Fabrication: Steel with baked enamel finish.

E. Color: As selected by Architect from manufacturer's standard range.

2.3 CEILING SLOT DIFFUSERS

A. Type: Continuous 1/2 inch (13 mm) wide slot, 1 slots wide, with adjustable vanes for left, right, or vertical discharge; integral ceiling fire damper.

B. Fabrication: Aluminum extrusions with factory clear lacquer finish.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket, mitered end border.

E. Plenum: Integral, galvanized steel, insulated.

2.4 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 face.

B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.

C. Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.

D. Color: To be selected by Architect from manufacturer's standard range.

2.5 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

A. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch (13 by 13 by 13 mm) grid core.

B. Fabrication: Grid core consists of aluminum with mill aluminum finish.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.

E. Frame: Channel lay-in frame for suspended grid ceilings.

F. Accessories: Provide integral gang and face operated opposed blade damper, 2 inch filter frame (50 mm), plaster frame, square mesh insect screen, square mesh debris screen,

prescored molded fiberglass back, and 45 degree angled eggcrate or other similar provisions for visual blocking such as angled louver or 90 degree duct elbow.

2.6 FABRIC AIR DISTRIBUTION DEVICES

A. General Requirements:

1. Diffuser material to comply with ASTM E84, UL 723, UL 2518, NFPA 90A, and NFPA 90B.
2. Air Dispersion Method:
3. Hanger Supports:

2.7 LOUVERS

A. Manufacturers:

1. ~~NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.~~Greenheck.
2. Ruskin Company; _____: www.ruskin.com/#sle.

B. Type: 4 inch (100 mm) deep frame with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch (13 mm) square mesh screen over intake or exhaust end.

C. Fabrication: 16 gauge, 0.0598 inch (1.52 mm) thick galvanized steel thick galvanized steel welded assembly, with factory prime coat finish.

D. Color: As indicated on the drawings.

E. Mounting: Furnish with interior flat flange for installation.

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 comply with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black, see Section 09 91 23.

3.2 PROTECTION

A. Protect installed products until completion of project.

B. Replace, repair, or touch-up damaged products before Substantial Completion.

END OF SECTION 23 37 00

SECTION 23 52 16 - CONDENSING BOILERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Manufactured units.

B. Boiler construction.

C. Boiler trim.

D. Fuel burning system.

E. Factory installed controls.

1.2 RELATED REQUIREMENTS

A. Section 23 21 14 - Hydronic Specialties.

B. Section 23 21 23 - Hydronic Pumps.

C. Section 25 15 00 - Integrated Automation Software.

D. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.

B. ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2022.

C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2026).

E. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2025, with Errata.

F. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); Current Edition.

G. NFPA 58 - Liquefied Petroleum Gas Code; 2024, with Amendment.

H. SCAQMD 1146.1 - Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters; 1990, with Amendment (2018).

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.

C. Manufacturer's Installation Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.

D. Manufacturer's Factory Inspection Report: Submit boiler inspection prior to shipment.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Provide a ~~five~~ten year warranty to include coverage for heat exchanger.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ~~Natural Gas,~~ Propane~~, or Combination Natural Gas/Propane~~Condensing Hot Water Boilers for Indoor Applications:

1. ~~Bradford White Corporation; _____: www.bradfordwhite.com/#sle.~~Heat Transfer Products (HTP)
2. LAARS Heating Systems Company; _____: www.laars.com/#sle.
3. Lochinvar LLC; _____: www.lochinvar.com/#sle.
4. _____.

2.2 MANUFACTURED UNITS

A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.

B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

2.3 BOILER CONSTRUCTION

A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.

B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.

C. Required Directory Listings:

1. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
2. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.

D. Heat Exchanger: Constructed of stainless steel to prevent corrosion. ~~with materials that are impervious to corrosion where subject to contact with corrosive condensables~~.

E. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.

F. Insulate casing with insulation material, protected and covered by heavy-gauge metal jacket.

G. Factory apply boiler base and other components, that are subject to corrosion, with durable, acrylic, powder coated, painted, or weather-proofed finish.

2.4 BOILER TRIM

A. ASME rated pressure relief valve.

B. Flow switch.

C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.

D. Temperature and pressure gauge.

E. Condensate neutralization tank.

F. Pressure Switches:

1. High gas pressure.
2. Low gas pressure.
3. Air pressure.

G. Manual reset high limit.

H. Boiler Pump (where required by boiler design):

1. Primary pump, factory supplied and sized for field installation to ensure minimum, continuous circulation through boiler.
2. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler manufacturer's recommendations.
3. Pump time delay.

2.5 FUEL BURNING SYSTEM

A. Provide ~~forced draft automatic burner or pulse combustion~~forced draft automatic burner, integral to boiler, designed to burn ~~natural gas, propane, and No. 2 fuel oil~~propane, and maintain fuel-air ratios automatically.

1. Blower Design: Statically and dynamically balanced to supply combustion air; direct connected to motor.

2. Forced Draft Design: Mixes combustion air and gas to achieve 90 percent combustion efficiency.
3. Pulse Combustion Design: Self-aspirating, not requiring blower for combustion.
4. Combustion Air Filter: Protects fuel burning system from debris.

B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and gas mixture.

C. Emission of Oxides of Nitrogen Requirements: Comply with SCAQMD 1146.1 for natural gas fired system, as applicable.

D. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through a sealed intake pipe.

2.6 FACTORY INSTALLED CONTROLS

A. Option for internal or external (0-10) VDC control.

B. Temperature Controls:

1. Automatic reset type to control fuel burning system on-off and firing rate to maintain temperature.
2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding safe system water temperature.
3. Low-fire start time delay relay.

C. Electronic PI setpoint/modulation control system.

D. Microprocessor-based, fuel/air mixing controls.

E. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.

1. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install boiler and provide connection of liquified petroleum gas service in accordance with requirements of NFPA 58 and applicable codes.

C. Pipe relief valves to nearest floor drain.

D. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

E. Install primary boiler pump in accordance with Section 23 21 23.

F. Provide piping connection and accessories in accordance with Section 23 21 14.

G. Provide for connection to electrical service in accordance with Section 26 05 83.

H. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 15 00.

3.2 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

END OF SECTION 23 52 16

SECTION 23 64 23 - SCROLL WATER CHILLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air-cooled scroll water chillers.

B. Water-cooled scroll water chillers.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete housekeeping pads.

B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

C. Section 23 08 00 - Commissioning of HVAC.

D. Section 23 09 93 - Sequence of Operations for HVAC Controls.

E. Section 23 21 13 - Hydronic Piping.

F. Section 23 21 14 - Hydronic Specialties.

G. Section 25 15 00 - Integrated Automation Software.

H. Section 25 35 19 - Integrated Automation Control Valves.

I. Section 26 05 83 - Wiring Connections.

1.3 REFERENCE STANDARDS

A. AHRI 550/590 (I-P) - Standard for Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle; 2023.

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2026).

E. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .

F. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

G. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

D. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.

E. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories; include trouble-shooting guide.

F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum five year warranty to include coverage for materials and labor for compressor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Daikin Applied Americas, Inc; _____: www.daikinapplied.com/#sle.

B. Trane Technologies, PLC; _____: www.trane.com/#sle.

C. York, a brand of Johnson Controls International, PLC; _____: www.york.com/#sle.

2.2 SCROLL-WATER CHILLER PERFORMANCE REQUIREMENTS

A. Packaged Water-Cooled Chiller, CH-1:

1. Refrigerant: R-454B; use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) no greater than that allowed by federal code.
2. Evaporator:
    a. Fouling Factor: 0.00010 sq ft-hr-degrees F/Btu (0.000018 sq m-hr-degrees C/W).
3. Packaged Water-Cooled Condenser:
    a. Fouling Factor: 0.00025 sq ft-hr-degrees F/Btu (0.000044 sq m-hr-degrees C/W).

2.3 WATER-COOLED, SCROLL WATER CHILLER

A. Factory assembled and tested chiller consisting of compressor(s), compressor motor(s), evaporator, condenser, enclosure, refrigeration circuits(s) and specialties, interconnecting piping, starters, and microprocessor-based controls.

1. Rating: AHRI 550/590 (I-P).
2. Safety: UL 1995 and ASHRAE Std 15.

3. Construction and Testing: ASME BPVC-VIII-1 as applicable for construction type.
4. Energy Efficiency: ASHRAE Std 90.1.
5. Enclosures:

    a. Frame: Heavy-gauge steel with hot-dipped galvanized or air-dried paint finish.

    b. Steel Cabinets: Factory apply baked on enamel or baked on powder paint finish.

    c. Perform 500-hour minimum salt spray test in accordance with ASTM B117.

B. Hermetic Scroll Compressor:

1. Unit: Fully hermetic type with multiple, direct drive compressors with discharge and suction service valves.
2. Vibration Control: Factory installed internal isolators or field installed external isolators.
3. Oil Lubrication System: Initial oil charge, oil sump, heater, oil level, and sight glass.
4. Capacity Reduction System: Compressor staging with control down to ~~12~~25 percent of full load without the activation of hot gas bypass.
5. Motor: 3600 or 3500 rpm, suction gas-cooled, with thermal or current overload protection.

C. Evaporator:

1. Brazed plate type.

    a. Plate Material: 316 stainless steel.

    b. Working Pressure Rating, Refrigerant Side: 430 psi (2965 kPa) minimum.

    c. Working Pressure Rating. Water Side: 150 psi (1034 kPa) minimum.

    d. End Connections: Provide with flanged or grooved connections.

    e. Cold Surface Insulation.

        1) Insulation is factory or field installed on evaporator, connections, and suction piping.

        2) 0.75 inches (20 mm) minimum thick, closed cell, expanded polyvinyl chloride, polyurethane, or Armaflex II insulation with a maximum K factor of 0.28.

    f. Provide factory installed vents and water drain connections on evaporator or piping.

    g. Provide factory installed fittings for temperature control sensors on evaporator or piping.

    h. Freeze Protection for Outdoor Locations: Provide thermostatically controlled electric heater to protect from freezing at ambient temperatures down to minus 20 degrees F (minus 28.9 degrees C).

D. Air-Cooled Condenser, Flat Tube-Plate Manifold Type:

1. Finned-Tube Type:
    a. Mechanically bond aluminum fins to copper tubing and protect with corrosion resistant materials or coatings.
    b. Clean, dehydrate and test.
    c. Leak Test: 650 psi (4482 kPa) minimum.
2. Coil Guards: Provide corrosion proof, louvered panels, heavy gauge wire panels, or grilles, factory installed. Protect condenser coil by enclosing with heavy plastic to prevent damage during shipping or rigging.
3. Fans and Motors:
    a. Fans: Dynamically balance propeller, shrouded-axial, or airfoil type fans of reinforced polymer or glass fiber reinforced composite corrosion resistant construction equipped with sealed, permanently lubricated ball bearings.
    b. Discharge Fan Guards: Corrosion resistant, heavy gauge, steel wire.
    c. Discharge Direction: Vertical.
    d. Motors: Direct drive, totally enclosed for outdoor use with current overload protection.

E. Refrigerant Circuits:
1. Provide multiple independent refrigeration circuits with one or multiple compressor(s) per circuit.
2. Provide liquid line shut-off valve, filter-drier, expansion valve, and refrigerant relief device for each independent circuit.

F. Controls Package:
1. Unit Controls: Factory-supplied DDC:
    a. Control-panel mounted with required input-output expansions, power supply, fused disconnect, hand switches, knobs, and accessories required to control chiller unit to manufacturer required sequences to meet intended use with listed performance.
    b. Factory configured to interface prewired sensors, switches, and safeties with allowance to add up to four chiller valves and flow sensors.
    c. Graphic-based touchscreen to include unit operation controls and user filter based interface for faults, alarms, performance, unit diagnostics, and data recording up to 12 months.
    d. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
    e. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.

f. Isolation Valves: Field-installed, 2-position, butterfly type with position tracking; see Section 25 35 19.

2. Prewire, assemble, factory mount, and test operating and safety control system consisting of a digital display or gauges, on-auto-off switch, motor starters, disconnect switches, power and control wiring. Provide controls, monitoring, programmable setpoints, alarms, and BAS as defined below:

a. Automatic Adjustable Operating Controls:

1) Temperature of chilled water leaving chiller.

2) Chiller system capacity control based on setpoints and system load.

3) Compressor short-cycling prevention.

4) Lead/lag for multiple compressors.

5) Automatic reset on power source failure.

6) Load limiting.

b. Normal Operation Monitoring and Open Coverless Displays:

1) Hours of operation.

2) Suction and discharge refrigerant pressures.

3) Automatic diagnostics.

4) Number of starts.

5) On/off compressor status.

6) Entering and leaving chilled water temperatures.

7) Status of operation.

8) Condenser water entering and leaving temperatures.

9) Weekly purge cycle totalization if applicable.

10) Oil pressure.

c. Setpoints:

1) Leaving chilled water temperature.

2) Date/time.

d. Automatic Chiller Shut-Down Safety Controls and Alarm:

1) Automatic Reset:

(a) Chilled water flow interlock.
(b) Voltage protection; over and under.
(c) Phase reversal protection.

2) Manual Reset:

(a) Evaporator low pressure.

(b) High motor winding temperature.
(c) Low chilled water temperature.
(d) Low chilled water flow.
(e) High condenser refrigerant discharge pressure.
(f) Motor current overload and phase loss.
(g) Low oil flow.

3) Remote Alarm: Activate remote, audible bell upon safety shutdown of chiller.

e. Points for Remote Monitoring and Control:

1) Minimum Data Transmission to BAS:

(a) All system operating conditions.
(b) Capacity control information.
(c) Safety shutdown conditions.

2) Minimum Operating Commands from BAS:

(a) Remote unit start/stop.
(b) Remote chilled water reset.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on steel or concrete foundations.

C. Install units on vibration isolators.

D. Connect to electrical service.

E. Connect to chilled water piping.

F. Arrange piping for easy dismantling to permit tube cleaning and removal.

G. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 15 00.

3.2 MANUFACTURER'S FIELD SERVICES

A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.

B. Supply initial charge of refrigerant and oil if not completely factory charged.

C. Demonstrate system operations and verify specified performance.

3.3 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.

2. Conduct walking tour of project.
3. Briefly describe function, operation, and maintenance of each component.

B. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

END OF SECTION 23 64 23

SECTION 23 73 13 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Casing construction.

B. Fan section.

C. Coil section.

D. Filter and air cleaner section.

E. Damper section.

F. Airflow measurement.

G. Access section.

H. Air blender section.

1.2 RELATED REQUIREMENTS

A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

B. Section 23 33 00 - Air Duct Accessories: Flexible duct connections.

C. Section 23 34 13 - Axial HVAC Fans.

1.3 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015, with Errata (2026).

B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

C. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.

D. AMCA 99 - Standards Handbook; 2025.

E. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

F. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

H. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

I. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2025.

J. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

M. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data:

1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
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.

C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Include installation instructions.

E. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements for additional provisions.
2. Extra Fan Belts: One set for each unit.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.6 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Daikin Applied; _____: www.daikinapplied.com/#sle.

B. Trane Technologies, PLC; _____: www.trane.com/#sle.

C. York, a brand of Johnson Controls International, PLC; _____: www.york.com/#sle.

2.2 CASING CONSTRUCTION

A. Full Perimeter Base Rail:

1. Construct of galvanized steel.
2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.

B. Casing:

1. Construct of one piece, insulated, double wall panels.
2. Provide mid-span, no through metal, internal thermal break.
3. Construct outer panels of galvanized steel and inner panels of galvanized steel.
4. Casing Air Pressure Performance Requirements:

a. Able to withstand up to ~~8 in-wc (2 kPa)~~6 in-wc (__ kPa) positive or negative static pressure.

b. Not to exceed 0.0042 inches per inch (0.000165 mm per mm) deflection at 1.5 times design static pressure up to a maximum of plus 8 in-wc (2 kPa) in positive pressure sections and minus 8 in-wc (2 kPa) in negative pressure sections.

C. Access Doors:

1. Construction, thermal and air pressure performance same as casing.
2. Provide surface mounted handles on hinged, swing doors.

D. Unit Flooring: Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities.

E. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.

F. Insulation: Foamed-in place.

1. Provide minimum thermal thickness of 12 R (2.29 RSI) throughout.
2. Completely fill panel cavities in each direction to prevent voids and settling.
3. Comply with NFPA 90A.

G. Drain Pan Construction:

1. Provide cooling coil and humidifier sections with an insulated, double wall, galvanized steel drain pan complying with ASHRAE Std 62.1 for indoor air quality and sufficiently sized to collect all condensate.

2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.

H. Marine Lights:

1. Provide factory-mounted, water- and dust-resistant LED fixture(s) where indicated on drawings, with the following characteristics:

a. Non-ferrous metal housing.

b. Glass or polycarbonate lens.

c. Factory wired to a single switch within factory provided service module.

d. Instant on white light with minimum 8,000 hour service life.

2. Provide factory installed service module including GFCI receptacle independent from load side; designed to receive power from field supplied 120 volt source.

I. Finish:

1. Indoor Units:

a. Provide exterior, galvanized steel panels without paint.

b. Color: Manufacturer's standard color.

2.3 FAN SECTION

A. Type: Forward curved, single width, single inlet, centrifugal plug fan, in accordance with AMCA 99. See Section 23 34 13

B. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.

E. Mounting:

1. Locate fan and motor internally on welded steel base coated with corrosion resistant paint.
2. Factory mount motor on slide rails.
3. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.

F. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.

G. Motor Wiring Conduit: Factory wire fan motor wiring to the unit mounted starter-disconnect, variable frequency drive, and external motor junction box.

H. Fan Accessories:

1. Discharge dampers.

I. Flexible Duct Connections:

1. For separating fan, coil, and adjacent sections.

J. Drives:

1. Comply with AMCA 99.
2. Bearings: Heavy duty pillow block type, ball bearings, with ABMA STD 9 L-10 life at 50,000 hours.
3. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.
4. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and 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, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
5. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch (2.6 mm) thick, 3/4 inch (20 mm) diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.4 COIL SECTION

A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

B. Drain Pans: 24 inch (600 mm) downstream of coil and down spouts for cooling coil banks more than one coil high.

C. Eliminators: Three break of galvanized steel, mounted over drain pan.

D. Air Coils:

1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.

E. Fabrication:

1. Tubes: 5/8 inch (16 mm) OD seamless copper expanded into fins, brazed joints.
2. Fins: Aluminum.
3. Casing: Die formed channel frame of galvanized steel.

F. Water Heating Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

G. Water Cooling Coils:

1. Headers: ~~Cast iron, s~~Seamless copper tube~~, or prime coated steel pipe~~ with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

2.5 FILTER AND AIR CLEANER SECTION

A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.

B. Hi-Efficiency Filters:

1. Media: 2 inch (50 mm) prefilter and 4 inch (305 mm) closely spaced, pleated, fine fiber, hi-efficiency filter, sealed into a rigid frame, and capable of operating up to a maximum of 625 fpm (3.17 mps) without loss of efficiency and holding capacity.
2. Filter Rack: Side-access designed to hold rigid frames.
3. Minimum Efficiency Reporting Value: 11 MERV when tested in accordance with ASHRAE Std 52.2.

C. Differential Pressure Gauge:

1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F (minus 6.7 degrees C) to 120 degrees F (48.9 degrees C).

2.6 DAMPER SECTION

A. Mixing Section: Provide a functional section to support the damper assembly for modulating the volume of outdoor, return, and exhaust air.

B. Damper Blades:

1. Double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on each blade.
2. Self-lubricating stainless steel or synthetic sleeve bearings.
3. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
4. Provide leakage testing and pressure ratings in compliance with AMCA 500-D test methods.
5. Arrange in parallel or opposed-blade configuration.

2.7 AIRFLOW MEASUREMENT

A. Airflow Meter:

1. Provide airflow measurement system to directly measure fan airflow or measure differential pressure that can be used to calculate airflow without interfering with submitted airflow performance and noise levels.
2. Accuracy: Plus/minus 5 percent when operating within the stable operating region of the fan curve.

2.8 ACCESS SECTION

A. Provide where indicated on drawings to allow for inspection, cleaning, and maintenance of field-installed components.

B. Construct access doors same as previously specified within this Section.

2.9 AIR BLENDER SECTION

A. Provide factory engineered air mixers incorporating fixed blades with no moving parts.

B. Construction:

1. Material: 0.80-inch (20.32 mm) aluminum, carbon steel, galvanized steel, aluminized steel, or stainless steel.
2. Welded and mechanically fastened.
3. Finish: Galvanized.

C. Factory install with adequate distances upstream and downstream, based on cataloged performance with a minimum, effectiveness of 70 percent outside air or within plus/minus 6 degrees F (2.73 degrees C) of theoretical mixed air temperature, at a minimum distance of one mixer diameter downstream of the mixer.

D. Include pressure loss due to mixer design and mixer-to-plenum ratio in the pressure drop rating for the static air mixer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Bolt sections together with gaskets.

C. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.

D. Provide fixed sheaves required for final air balance.

E. Make connections to coils with unions or flanges.

F. 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.

G. Cooling Coils:

1. Pipe drain and overflow to nearest floor drain.

3.2 SYSTEM STARTUP

A. Provide manufacturer's field representative to perform systems startup.

B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

C. Adjust for proper operation within manufacturer's published tolerances.

3.3 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training for additional requirements.

C. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.
2. Conduct walking tour of project.
3. Briefly describe function, operation, and maintenance of each component.

D. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

END OF SECTION 23 73 13

SECTION 23 81 26.13 - SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air-source heat pumps.

B. Air cooled condensing units.

C. Indoor air handling (fan and coil) units for ductless systems.

D. Controls.

1.2 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2026.

B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

D. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.

E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

G. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

D. Design Data: Indicate refrigerant pipe sizing.

E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.4 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturers warranty for ~~heat exchangers~~heat exchangers, condensing units, and compressors.

PART 2 PRODUCTS

2.1 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.

1. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.

2.2 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

A. Manufacturers:

1. ~~Ouellet: www.ouellet.com/#sle.~~Mitsubishi.
2. ~~Rheem Manufacturing Company Inc; _____: www.rheem.com/#sle.~~Samsung.
3. Trane Technologies, PLC; _____: www.trane.com/#sle.

B. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

1. Location: Ceiling.
2. Cabinet: Galvanized steel.
    a. Finish: White.
3. Fan: Line-flow fan direct driven by a single motor.
4. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.

C. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
2. Manufacturer: System manufacturer.

D. Provide factory installed refrigerant detection and alarm systems.

2.3 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

1. Refrigerant: R-454B~~.~~ or R-32.
2. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.

3. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.

B. Compressor: Hermetic, two speed 1800 and 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high-pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.

C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

1. Condenser Fans: Direct-drive propeller type.
2. Condenser Fan Motor: Enclosed, 1-phase type, permanently lubricated.

D. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).

1. Provide thermostatic expansion valves.

E. Operating Controls:

1. Control by room thermostat to maintain room temperature setting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available and in correct location.

C. Verify that proper fuel supply is available for connection.

3.2 INSTALLATION

A. Install in accordance with NFPA 90A and NFPA 90B.

B. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION 23 81 26.13

SECTION 23 83 00 - RADIANT HEATING AND COOLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hydronic radiant panel heaters.

1.2 REFERENCE STANDARDS

A. ASHRAE Std 138 - Method of Testing for Rating Ceiling Panels for Sensible Heating and Cooling; 2021.

B. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2026.

C. DIN EN 14037-2 - Free Hanging Heating and Cooling Surfaces for Water with a Temperature Below 120 Degrees C - Part 2: Pre-Fabricated Ceiling Mounted Radiant Panels for Space Heating - Test Method for Thermal Output; 2016.

D. DIN EN 14037-3 - Free Hanging Heating and Cooling Surfaces for Water with a Temperature Below 120 Degrees C - Part 3: Prefabricated Ceiling Mounted Radiant Panels for Space Heating - Rating Method and Evaluation of Radiant Thermal Output; 2016.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for ~~ceiling panel heaters, electric cabling, electric mats, electric infrared radiant heaters, and [____]~~ceiling panel heaters.

PART 2 PRODUCTS

2.1 HYDRONIC RADIANT PANEL HEATERS

A. Manufacturers:

1. Price Industries; _____: www.price-hvac.com/#sle.
2. Sterling.
3. TWA Panel Systems, Inc; _____: www.twapanels.ca.

B. Modular Radiant Ceiling Panels: Heat sinks located behind panel, transfer heat between copper tubes and panel face, and radiate heat to zone. Factory provided, cut-to-fit 1" thick insulation.

1. Water Tubes:

a. ASTM B75/B75M copper tubing, 1/2 inch (12.7 mm) minimum nominal diameter.

b. Water Connections:

1) Suitable for solder, compression fittings, push-on fittings, or threaded connection.

2) Protect with removable seals. Prevent introduction of dirt and dust during shipping.

2. Heat Sink Construction:
    a. Mechanically fasten extruded aluminum and copper pipe to heat sink.
    b. Provide non-hardening heat transfer paste between tubing, heat sink, and panel.
3. Panel Face: Construct of minimum 18 gauge, 0.0403 inch (1.236 mm) thick aluminum.
4. Finish:
    a. Apply ~~polyester paint, manufacture's standard finish, or [____]~~manufacture's standard finish.
    b. Maintain optimal radiative properties, durability, and cleanability.
5. Water Pressure Drop and Heating Output Data: Derive from factory testing in accordance with ASHRAE Std 138 or DIN EN 14037, Parts 2 and 3.

PART 3 EXECUTION

3.1 EXAMINATION

A. ~~Hydronic, Electric, and [____]~~Hydronic Radiant Ceiling Panel Heaters:
1. Examine areas to receive radiant heating units for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Ensure surfaces in contact with radiant heating panels are free of burrs and sharp protrusions.
3. Ensure surfaces are level and plumb.
4. Proceed with installation only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. ~~Hydronic, Electric, and [____]~~Hydronic Radiant Ceiling Panel Heaters:
1. Install level and plumb.
2. Suspend from structure.
3. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
4. Provide tamper-proof, balancing valve with memory stop on return piping.
5. Provide float operated automatic air vents with stop valve.

3.3 CLEANING

A. Radiant Ceiling Panel Heaters: Remove paint splatters, other spots, dirt, and debris.

3.4 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 23 83 00

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.

B. Underground feeder and branch-circuit cable.

C. Service entrance cable.

D. Armored cable.

E. Metal-clad cable.

F. Variable-frequency drive cable.

G. Manufactured wiring systems.

H. Wiring connectors.

I. Electrical tape.

J. Heat shrink tubing.

K. Oxide inhibiting compound.

L. Wire pulling lubricant.

M. Cable ties.

N. Firestop sleeves.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conductors.

F. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

G. Section 31 23 16 - Excavation.

H. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

I. Section 31 23 23 - Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).

E. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation; 2018 (Reapproved 2023).

F. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2024.

G. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2020.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

I. FM 3971 - Examination Standard for Fire Protective Coatings and Wraps for Grouped Cables; 2023.

J. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); 2008a (Validated 2019).

K. IEEE 1210 - IEEE Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable; 2004 (Corrigendum 2014).

L. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

M. NECA 104 - Standard for Installing Aluminum Building Wire and Cable; 2012.

N. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.

O. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.

P. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

Q. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

R. UL 4 - Armored Cable; Current Edition, Including All Revisions.

S. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

T. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

U. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.

V. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

W. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

X. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

Y. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

Z. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.

AA. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.

D. Wire Pulling Lubricant: Certification of compatibility with conductors/cables where used with the following insulation/jacket types:

1. Low-smoke zero halogen (LSZH).
2. Low-density polyethylene (LDPE).
3. Semiconducting.

E. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

F. Field Quality Control Test Reports.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (-10 degrees C), unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

1. Exceptions:

a. Use manufactured wiring systems for branch circuits where concealed above accessible ceilings for lighting.

1) Exception: Provide single conductor building wire in raceway for circuit homerun from distribution box to panelboard.

b. Use variable-frequency drive cable for connection between variable-frequency motor controllers and associated motors.

C. Nonmetallic-sheathed cable is not permitted.

D. Service entrance cable is not permitted.

E. Armored cable is permitted only as follows:

1. Where not otherwise restricted, may be used:

a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.

b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.

2. In addition to other applicable restrictions, may not be used:

a. Where not approved for use by the authority having jurisdiction.

b. Where exposed to view.

c. Where exposed to damage.

d. For damp, wet, or corrosive locations.

F. Metal-clad cable is permitted only as follows:

1. Where not otherwise restricted, may be used:

a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.

b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.

2. In addition to other applicable restrictions, may not be used:

a. Where not approved for use by the authority having jurisdiction.

b. Where exposed to view.

c. Where exposed to damage.

d. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.

G. Manufactured wiring systems are permitted only as follows:

1. Where not otherwise restricted, may be used:

a. For branch circuits where concealed above accessible ceilings for lighting and in open ceiling areas for lighting.

1) Exception: Provide single conductor building wire in raceway for circuit homerun from distribution box to panelboard.

2. In addition to other applicable restrictions, may not be used:

a. Where not approved for use by the authority having jurisdiction.

b. Where exposed to view.

c. Where exposed to damage.

d. For damp, wet, or corrosive locations.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide conductors and cables with lead content less than 300 parts per million.

D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

E. Comply with NEMA WC 70.

F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

H. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

I. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

J. Conductor Material:

1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.

K. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.

a. Exceptions:

1) 20 A, 120 V circuits longer than 125 feet (_____ m): 10 AWG, for voltage drop.

2) 20 A, 120 V circuits longer than 175 feet (_____ m): 8 AWG, for voltage drop.

3) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.

2. Control Circuits: 14 AWG.

L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

M. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
    a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
3. Color Code:
    a. 480Y/277 V, 3 Phase, 4 Wire System:
        1) Phase A: Brown.
        2) Phase B: Orange.
        3) Phase C: Yellow.
        4) Neutral/Grounded: Gray.
    b. 208Y/120 V, 3 Phase, 4 Wire System:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.
        4) Neutral/Grounded: White.
    c. Equipment Ground, All Systems: Green.
    d. Travelers for 3-Way and 4-Way Switching: Pink.
    e. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:

1. Copper Building Wire:
    a. Cerro Wire LLC: www.cerrowire.com/#sle.
    b. Encore Wire Corporation: www.encorewire.com/#sle.
    c. General Cable Technologies Corporation; _____: www.generalcable.com/#sle.
    d. Service Wire Co: www.servicewire.com/#sle.
    e. Southwire Company: www.southwire.com/#sle.
    f. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:

1. Feeders and Branch Circuits:

a. Size 14 AWG and Smaller: Solid.

b. Size 12 AWG and Larger: Stranded.

2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:

1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

a. Size 4 AWG and Larger: Type XHHW-2.

b. Installed Underground: Type XHHW-2.

c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.4 ARMORED CABLE

A. Manufacturers:

1. AFC Cable Systems Inc: www.afcweb.com/#sle.
2. Encore Wire Corporation: www.encorewire.com/#sle.
3. Southwire Company: www.southwire.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:

1. Size 14 AWG and Smaller: Solid.
2. Size 12 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN.

F. Grounding: Combination of interlocking armor and integral bare bonding wire.

G. Armor: Steel, interlocked tape.

2.5 METAL-CLAD CABLE

A. Manufacturers:

1. AFC Cable Systems Inc: www.afcweb.com/#sle.
2. Encore Wire Corporation: www.encorewire.com/#sle.
3. Service Wire Co: www.servicewire.com/#sle.
4. Southwire Company: www.southwire.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:

1. Size 14 AWG and Smaller: Solid.
2. Size 12 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Provide dedicated neutral conductor for each phase conductor.

G. Grounding: Full-size integral equipment grounding conductor.

H. Armor: Steel, interlocked tape.

I. Provide PVC jacket applied over cable armor.

2.6 VARIABLE-FREQUENCY DRIVE CABLE

A. Manufacturers:

1. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.

C. Conductor Stranding: Stranded.

D. Insulation Voltage Rating: 1000 V.

E. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.

F. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.

G. Provide metallic shielding.

2.7 MANUFACTURED WIRING SYSTEMS

A. Manufacturers:

1. AFC Cable Systems Inc: www.afcweb.com/#sle.
2. D&P Custom Lights & Wiring Systems, Inc: www.dandpcustomlights.com/#sle.
3. RELOC Wiring Solutions, a brand of Acuity Brands, Inc: www.relocwiring.com/#sle.

4. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Manufactured wiring assemblies complying with NFPA 70 Article 604, and listed and labeled as complying with UL 183.

C. Provide components necessary to transition between manufactured wiring system and other wiring methods.

D. Branch Circuit Cables:

1. Conductor Stranding (Size 14 AWG and Smaller): Solid.
2. Insulation Voltage Rating: 600 V.
3. Insulation: Type THHN.
4. Provide dedicated neutral conductor for each phase conductor where indicated or required.
5. Grounding: Full-size integral equipment grounding conductor.
6. Armor: Steel, interlocked tape.

E. Connectors: Keyed and color-coded to prevent interconnection of different voltages.

F. Fixture Leads: Type TFN insulation.

2.8 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.

C. Wiring Connectors for Splices and Taps:

1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.

6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
7. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

1. Manufacturers:

a. 3M: www.3m.com/#sle.

b. Ideal Industries, Inc: www.idealindustries.com/#sle.

c. NSI Industries LLC: www.nsiindustries.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

H. Mechanical Connectors: Provide bolted type or set-screw type.

1. Manufacturers:

a. Burndy LLC; _____: www.burndy.com/#sle.

b. nVent ILSCO: www.ilsco.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.

1. Manufacturers:

a. Burndy LLC; _____: www.burndy.com/#sle.

b. nVent ILSCO: www.ilsco.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

1. Manufacturers:

a. Burndy LLC: www.burndy.com/#sle.

b. Ilsco: www.ilsco.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2.9 ACCESSORIES

A. Electrical Tape:

1. Manufacturers:

a. 3M: www.3m.com/#sle.

b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.

c. Substitutions: See Section 01 60 00 - Product Requirements.

2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

a. Substitutions: See Section 01 60 00 - Product Requirements.

3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.
5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).
6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil (0.18 mm); suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil (2.3 mm).

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

1. Manufacturers:

a. 3M: www.3m.com/#sle.

b. Burndy LLC: www.burndy.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

1. Manufacturers:

a. Burndy LLC: www.burndy.com/#sle.

b. Ideal Industries, Inc: www.idealindustries.com/#sle.

c. Ilsco: www.ilsco.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Wire Pulling Lubricant:

1. Manufacturers:

a. 3M: www.3m.com/#sle.

b. American Polywater Corporation: www.polywater.com/#sle.

c. Ideal Industries, Inc: www.idealindustries.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Listed and labeled as complying with UL 267.
3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
4. Suitable for use at installation temperature.
5. Products:

a. American Polywater Corporation; Polywater J Cable Pulling Lubricant: www.polywater.com/#sle.

b. American Polywater Corporation; Polywater LZ Cable Pulling Lubricant: www.polywater.com/#sle.

c. Substitutions: See Section 01 60 00 - Product Requirements.

E. Cable Ties: Material and tensile strength rating suitable for application.

1. Manufacturers:

a. Burndy LLC: www.burndy.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

F. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.

1. Products:

    a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.

    b. Substitutions: See Section 01 60 00 - Product Requirements.

G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

1. Products:

    a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.

    b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated without specific routing, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Include circuit lengths required to install connected devices within 10 ft (3.0 m) of location indicated.
5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:

a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.

b. Increase size of conductors as required to account for ampacity derating.

c. Size raceways, boxes, etc. to accommodate conductors.

8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install armored cable (Type AC) in accordance with NECA 120.

E. Install metal-clad cable (Type MC) in accordance with NECA 120.

F. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

G. Exposed Cable Installation (only where specifically permitted):

1. Route cables parallel or perpendicular to building structural members and surfaces.
2. Protect cables from physical damage.

H. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

I. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

J. Terminate cables using suitable fittings.

1. Armored Cable (Type AC):

a. Use listed fittings and anti-short, insulating bushings.

b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.

2. Metal-Clad Cable (Type MC):

a. Use listed fittings.

b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.

K. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

L. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

M. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet (1.5 m) of slack.

N. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

O. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

P. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

Q. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.

a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.

b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.

2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.

a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.

b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.

3. Wet Locations: Use heat shrink tubing.

R. Insulate ends of spare conductors using vinyl insulating electrical tape.

S. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

T. Identify conductors and cables in accordance with Section 26 05 53.

U. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

V. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.

1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Ground access wells.

1.2 RELATED REQUIREMENTS

A. Section 09 65 00 - Resilient Flooring: Static control flooring.

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

1. Includes oxide inhibiting compound.

C. Section 26 05 36 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 56 00 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

F. Section 33 79 00 - Site Grounding.

1.3 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2025.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2022.

D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Shop Drawings:

1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field quality control test reports.

F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

E. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.

a. Provide continuous grounding electrode conductors without splice or joint.

b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

2. Metal Underground Water Pipe(s):

a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet (3.0 m) at an accessible location not more than 5 feet (1.5 m) from the point of entrance to the building.

b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.

c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Metal In-Ground Support Structure:

a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.

4. Concrete-Encased Electrode:

    a. Provide connection to concrete-encased electrode consisting of not less than 20 feet (6.0 m) of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

5. Ground Ring:

    a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than _____ in direct contact with earth, installed at a depth of not less than 30 inches (750 mm).

    b. Provide connection from ground ring conductor to:

        1) Perimeter columns of metal building frame.

        2) Ground rod electrodes located as indicated.

6. Ground Rod Electrode(s):

    a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.

    b. Space electrodes not less than 10 feet (3.0 m) from each other and any other ground electrode.

    c. Where location is not indicated, locate electrode(s) at least 5 feet (1.5 m) outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.

7. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
8. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.

    a. Ground Bar Size: 1/4 by 2 by 12 inches (6 by 50 by 300 mm) unless otherwise indicated or required.

    b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.

    c. Ground Bar Mounting Height: 18 inches (450 mm) above finished floor unless otherwise indicated.

9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.

F. Service-Supplied System Grounding:

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:

1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

H. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:

   a. Transformers (except autotransformers such as buck-boost transformers).

   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.

   c. Generators, when neutral is switched in the transfer switch.

2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.

7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

I. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:

    a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.

    b. Metal gas piping.

8. Provide bonding for metal building frame.
9. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
10. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.

J. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.

    a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.

    b. Raceway Size: 3/4 inch (21 mm) trade size unless otherwise indicated or required.

    c. Ground Bar Size: 1/4 by 2 by 12 inches (6 by 50 by 300 mm) unless otherwise indicated or required.

d. Ground Bar Mounting Height: 18 inches (450 mm) above finished floor unless otherwise indicated.

K. Cable Tray Systems: Also comply with Section 26 05 36.

L. Pole-Mounted Luminaires: Also comply with Section 26 56 00.

M. Static Control Flooring: Provide bonding of static control flooring provided in accordance with Section 09 65 00.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:

1. Use insulated copper conductors unless otherwise indicated.

a. Exceptions:

1) Use bare copper conductors where installed underground in direct contact with earth.

2) Use bare copper conductors where directly encased in concrete (not in raceway).

2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gauge of specified conductors.

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.

a. Exceptions:

1) Use mechanical connectors for connections to electrodes at ground access wells.

3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

a. Exceptions:

1) Use exothermic welded connections for connections to metal building frame.

4. Manufacturers - Mechanical and Compression Connectors:

a. Burndy LLC: www.burndy.com/#sle.

b. Harger Lightning & Grounding: www.harger.com/#sle.

c. nVent ERICO: www.nvent.com/#sle.

d. Thomas & Betts Corporation: www.tnb.com/#sle.

e. _____.

5. Manufacturers - Exothermic Welded Connections:

a. Burndy LLC: www.burndy.com/#sle.

b. nVent ERICO; Cadweld: www.nvent.com/#sle.

c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:

a. allG Fabrication: www.allgfab.com/#sle.

b. nVent ERICO: www.nvent.com/#sle.

c. Substitutions: See Section 01 60 00 - Product Requirements.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch (19 mm) diameter by 10 feet (3.0 m) length, unless otherwise indicated.
4. Manufacturers:

a. allG Fabrication: www.allgfab.com/#sle.

b. Galvan Industries, Inc: www.galvanelectrical.com/#sle.

c. Harger Lightning & Grounding: www.harger.com/#sle.

d. nVent ERICO: www.nvent.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

F. Ground Access Wells:

1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.

a. Areas Exposed to Vehicular Traffic: Rated for not less than _____ pounds (_____ kN) vertical design load.

2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.

a. Round Wells: Not less than 8 inches (200 mm) in diameter.

3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches (250 mm).
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers:

a. allG Fabrication: www.allgfab.com/#sle.

b. Harger Lightning & Grounding: www.harger.com/#sle.

c. nVent ERICO: www.nvent.com/#sle.

d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.

1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches (150 mm) below finished grade.
2. Indoor Installations: Unless otherwise indicated, install with 4 inches (100 mm) of top of rod exposed.

D. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.

C. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

D. Section 26 05 36 - Cable Trays for Electrical Systems: Additional support and attachment requirements for cable tray.

E. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

F. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

G. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

H. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

I. Section 27 05 29 - Hangers and Supports for Communications Systems.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
2. Coordinate work to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Maintain at project site one copy of each referenced document that prescribes execution requirements.

B. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

C. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with the following. Where requirements differ, comply with most stringent.

a. NFPA 70.

b. Requirements of authorities having jurisdiction.

2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of 2. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.

a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.

c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.

1. Manufacturers:

a. ABB: www.electrification.us.abb.com/#sle.

b. Eaton Corporation: www.eaton.com/#sle.

c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.

3. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

1. Manufacturers:

a. ABB: www.electrification.us.abb.com/#sle.

b. Eaton Corporation: www.eaton.com/#sle.

c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

D. Metal Channel/Strut Framing Systems:

1. Manufacturers:

a. ABB: www.electrification.us.abb.com/#sle.

b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.

c. Eaton Corporation: www.eaton.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

e. Source Limitations: Furnish channel/strut and associated fittings, accessories, and hardware produced by single manufacturer.

2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
3. Comply with MFMA-4.
4. Channel/Strut Used as Raceway, Where Indicated: Listed and labeled as complying with UL 5B.
5. Channel Material:

a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.

b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.

6. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm).
7. Minimum Channel Dimensions: 1-5/8 inch (41 mm) wide by 13/16 inch (21 mm) high.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

1. Minimum Size, Unless Otherwise Indicated or Required:

a. Equipment Supports: 1/2-inch (13 mm) diameter.

b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch (6 mm) diameter.

c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch (10 mm) diameter.

d. Trapeze Support for Multiple Conduits: 3/8-inch (10 mm) diameter.

e. Outlet Boxes: 1/4-inch (6 mm) diameter.

f. Luminaires: 1/4-inch (6 mm) diameter.

F. Anchors and Fasteners:

1. Manufacturers - Mechanical Anchors:

a. Dewalt: anchors.dewalt.com/#sle.

b. Hilti, Inc: www.hilti.com/#sle.

c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.

d. MKT Fastening: www.mktfasteningusa.com/#sle.

e. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.

f. Substitutions: See Section 01 60 00 - Product Requirements.

2. Manufacturers - Powder-Actuated Fastening Systems:

a. Dewalt: anchors.dewalt.com/#sle.

b. Hilti, Inc: www.hilti.com/#sle.

c. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Hollow Masonry: Use toggle bolts.
7. Hollow Stud Walls: Use toggle bolts.
8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
9. Sheet Metal: Use sheet metal screws.
10. Wood: Use wood screws.
11. Plastic and lead anchors are not permitted.
12. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

a. Manufacturer: Same as manufacturer of metal channel/strut framing system.

b. Comply with MFMA-4.

c. Channel Material: Use galvanized steel.

d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm) minimum base metal thickness.

13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install hangers and supports in accordance with NECA 1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Equipment Support and Attachment:

1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Unless otherwise indicated, mount floor-mounted equipment on properly sized concrete pad 4 inches (100 mm) in height; see Section 03 30 00.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Conduit Support and Attachment: See Section 26 05 33.13 for additional requirements.

J. Cable Tray Support and Attachment: See Section 26 05 36 for additional requirements.

K. Box Support and Attachment: See Section 26 05 33.16 for additional requirements.

L. Interior Luminaire Support and Attachment: See Section 26 51 00 for additional requirements.

M. Exterior Luminaire Support and Attachment: See Section 26 56 00 for additional requirements.

N. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

O. Secure fasteners in accordance with manufacturer's recommended torque settings.

P. Remove temporary supports.

Q. Identify independent electrical component support wires above accessible ceilings, where permitted, with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26 05 29

SECTION 26 05 33.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Galvanized steel intermediate metal conduit (IMC).

D. Flexible metal conduit (FMC).

E. Liquidtight flexible metal conduit (LFMC).

F. Galvanized steel electrical metallic tubing (EMT).

G. Rigid polyvinyl chloride (PVC) conduit.

H. Liquidtight flexible nonmetallic conduit (LFNC).

I. Reinforced thermosetting resin conduit (RTRC).

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 07 84 00 - Firestopping.

C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1. Includes additional requirements for fittings for grounding and bonding.

E. Section 26 05 29 - Hangers and Supports for Electrical Systems.

F. Section 26 05 33.16 - Boxes for Electrical Systems.

G. Section 26 05 33.23 - Surface Raceways for Electrical Systems.

H. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

I. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

J. Section 26 27 23 - Indoor Service Poles.

K. Section 27 05 33.13 - Conduit for Communications Systems.

L. Section 31 23 16 - Excavation.

M. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

N. Section 31 23 23 - Fill: Bedding and backfilling.

O. Section 33 71 19 - Electrical Underground Ducts, Ductbanks, and Manholes.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.

C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit - Aluminum (ERMC-A); 2025.

D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2025.

E. ASTM D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal); 2010 (Reapproved 2019).

F. ASTM D1598 - Standard Test Methods for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure; 2024.

G. ASTM D1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings; 2018 (Reapproved 2024).

H. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

I. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.

J. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; 2004.

K. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2025.

L. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

M. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

N. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

O. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series; 2015.

P. NEMA TC 14.AG - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; 2015 (Reaffirmed 2021).

Q. NEMA TC 14.BG - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; 2015 (Reaffirmed 2020).

R. NEMA TC 14.XW - Extra Heavy Wall Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; 2015 (Reaffirmed 2021).

S. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

T. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

U. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

V. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

W. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.

X. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

Y. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

Z. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

AA. UL 746C - Polymeric Materials – Use in Electrical Equipment Evaluations; Current Edition, Including All Revisions.

BB. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

CC. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

DD. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

EE. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

FF. UL 2420 - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Current Edition, Including All Revisions.

GG. UL 2515 - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Current Edition, Including All Revisions.

HH. UL 2515A - Standard for Supplemental Requirements for Extra Heavy Wall Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Shop Drawings:

1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
2. Include proposed locations of roof penetrations and proposed methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

A. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions and shop drawings.

B. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use rigid PVC conduit or reinforced thermosetting resin conduit (RTRC).

2. Exterior, Direct-Buried: Use rigid PVC conduit or reinforced thermosetting resin conduit (RTRC).
3. Exterior, Embedded Within Concrete: Use rigid PVC conduit or reinforced thermosetting resin conduit (RTRC).
4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), aluminum rigid metal conduit (RMC), or galvanized steel intermediate metal conduit (IMC) where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit (RMC) elbows, galvanized steel intermediate metal conduit (IMC) elbows, PVC-coated galvanized steel rigid metal conduit (RMC) elbows, or concrete-encased PVC elbows for bends.
6. Where galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) is installed in direct contact with earth where soil has resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
7. Where galvanized steel electrical metallic tubing (EMT) is installed in direct contact with earth, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
8. Where galvanized rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT) emerges from concrete into soil, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection for minimum of 4 inches (100 mm) on either side of where conduit emerges.

D. Embedded Within Concrete:

1. Within Slab on Grade: Use rigid PVC conduit or reinforced thermosetting resin conduit (RTRC). Embed within structural slabs only where approved by Structural Engineer.
2. Within Slab Above Ground: Use rigid PVC conduit or reinforced thermosetting resin conduit (RTRC). Embed within structural slabs only where approved by Structural Engineer.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) where emerging from concrete.
5. Where galvanized steel electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection for minimum of 4 inches (100 mm) on either side of where conduit emerges.

E. Concealed Within Masonry Walls: Use galvanized steel electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel electrical metallic tubing (EMT).

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).

1. Locations subject to physical damage include, but are not limited to:

a. Where exposed below 8 feet (2.4 m), except within electrical and communication rooms or closets.

b. Where exposed below 20 feet (6.1 m) in BACK OF HOUSE STAGING AREA.

K. Exposed, Interior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

1. Locations subject to severe physical damage include, but are not limited to:

a. High traffic industrial and warehouse areas where exposed below 8 feet (2.4 m), except within electrical and communication rooms or closets.

L. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel electrical metallic tubing (EMT).

M. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

1. Exterior locations subject to severe physical damage include, but are not limited to:

a. Where exposed to vehicular traffic below 20 feet (6.1 m).

N. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel electrical metallic tubing (EMT).

O. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).

1. Maximum Length: 6 feet (1.8 m).

P. Flexible Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit (FMC).
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
3. Maximum Length: 6 feet (1.8 m) unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:

a. Transformers.

b. Motors.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC) or galvanized steel electrical metallic tubing (EMT).

2.2 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Electrical Service Conduits: See Section 26 21 00 for additional requirements.

C. Fittings for Grounding and Bonding: See Section 26 05 26 for additional requirements.

D. Provide conduit, fittings, supports, and accessories required for complete raceway system.

E. Provide products listed, classified, and labeled as suitable for purpose intended.

F. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4-inch (21 mm) trade size.
2. Branch Circuit Homeruns: 3/4-inch (21 mm) trade size.
3. Control Circuits: 1/2-inch (16 mm) trade size.
4. Flexible Connections to Luminaires: 3/8-inch (12 mm) trade size.
5. Underground, Interior: 3/4-inch (21 mm) trade size.
6. Underground, Exterior: 1-inch (27 mm) trade size.

G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Rymco USA: www.rymcousa.com/#sle.
4. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
5. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Factory-Painted, Color-Coded Galvanized Steel RMC: Apply according to indicated color code.

1. See Section 26 05 53 for color code.

D. Fittings:

1. Manufacturers:

a. ABB; T&B: www.electrification.us.abb.com/#sle.

b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.

c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.

d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
3. Material: Use die cast zinc.

a. Where not subject to severe corrosive influence, stainless steel or aluminum fittings may be used.

4. Connectors and Couplings: Use threaded or threadless type fittings.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Rymco USA: www.rymcousa.com/#sle.
4. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
5. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
6. _____.

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:

1. Manufacturers:

a. ABB; T&B: www.electrification.us.abb.com/#sle.

b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.

c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.

d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
3. Material: Use aluminum.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.5 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:

1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Rymco USA: www.rymcousa.com/#sle.
4. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.

5. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:

1. Manufacturers:

a. ABB; T&B: www.electrification.us.abb.com/#sle.

b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.

c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.

d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.6 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.
3. International Metal Hose: www.metalhose.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

C. Fittings:

1. Manufacturers:

a. ABB; T&B: www.electrification.us.abb.com/#sle.

b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.

c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use die cast zinc.

2.7 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:

1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.
3. International Metal Hose: www.metalhose.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:

1. Manufacturers:

a. ABB; T&B: www.electrification.us.abb.com/#sle.

b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.

c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use die cast zinc.

2.8 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
2. Nucor Tubular Products: www.nucortubular/#sle.
3. Rymco USA: www.rymcousa.com/#sle.
4. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
5. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Factory-Painted, Color-Coded Galvanized Steel EMT: Apply according to indicated color code.

1. See Section 26 05 53 for color code.
2. Products:

a. Rymco USA; Real Color: www.rymcousa.com/#sle.

b. Allied Tube & Conduit, a division of Atkore International.

c. Wheatland Tube, a division of Zekelman Industries.

d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Fittings:

1. Manufacturers:

a. ABB; T&B: www.electrification.us.abb.com/#sle.

b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.

c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.

d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

4. Connectors and Couplings: Use compression/gland type.

a. Do not use indenter type connectors and couplings.

b. Do not use set-screw type connectors and couplings.

5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
6. Embedded Within Concrete, Where Permitted: Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.9 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:

1. ABB; Carlon: www.carlon.com/#sle.
2. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
3. Cantex Inc: www.cantexinc.com/#sle.
4. Heritage Plastics, a division of Atkore International: www.heritageplastics.com/#sle.
5. JM Eagle: www.jmeagle.com/#sle.
6. Rymco USA: www.rymcousa.com/#sle.
7. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.10 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Manufacturers:

1. Champion Fiberglass, Inc: www.championfiberglass.com/#sle.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Applications:

1. Above Ground, Not Subject to Physical Damage: Use aboveground (AG), SW (Standard Wall), HW (Heavy Wall), or XW (Extra Heavy Wall) RTRC.
2. Above Ground, Subject to Physical Damage: Use aboveground (AG), XW (Extra Heavy Wall) RTRC.
3. Underground, Direct-Buried: Use belowground (BG), DB (direct-burial) RTRC or aboveground (AG) RTRC.
4. Underground, Embedded in Concrete: Use belowground (BG), EB (encased-burial) RTRC, belowground (BG), DB (direct-burial) RTRC, or aboveground (AG) RTRC.
5. Do not use RTRC in hazardous/classified locations.

C. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).

1. Aboveground (AG), XW (Extra Heavy Wall) RTRC: Comply with NEMA TC 14.XW and list and label as complying with UL 2515A.
2. Belowground (BG) RTRC: Comply with NEMA TC 14.BG and list and label as complying with UL 2420.

D. Supports: As recommended by manufacturer.

E. Fittings: Same type and manufacturer as conduit to be connected.

1. Cement-Tight Joints: Use bonded coupling or bell and spigot.
2. Cement-Tight and Watertight Joints: Use adhesive and manufacturer's standard gaskets.

2.11 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch (0.51 mm).

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

E. Adhesive for HDPE and RTRC Conduit:

1. Specifically designed for bonding dissimilar materials in lieu of transition fittings, including but not limited to polyethylene, fiberglass, PVC, aluminum, and steel; UL 746C recognized.

2. Approved by adhesive manufacturer for use with materials to be joined.
3. Adhesive Shear Strength: Not less that 100 psi (720 kPa), when tested in accordance with ASTM D1002.
4. Hydrostatic Pressure Resistance: No leaks, when tested in accordance with ASTM D1598 at 120 psi (830 kPa) for 1,000 hours and when tested in accordance with ASTM D1599 at 250 psi (1700 kPa).
5. Products:

    a. American Polywater Corporation; Polywater BonDuit Conduit Adhesive: www.polywater.com/#sle.

    b. Substitutions: See Section 01 60 00 - Product Requirements.

F. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf (5.6 kN).

G. Foam Conduit Sealant:

1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
3. Rated to hold minimum of 10 ft (3.0 m) water head pressure.
4. Products:

    a. American Polywater Corporation; Polywater AFT Foam Duct Sealant: www.polywater.com/#sle.

    b. American Polywater Corporation; Polywater FST Foam Duct Sealant: www.polywater.com/#sle.

    c. Substitutions: See Section 01 60 00 - Product Requirements.

H. Conduit Mechanical Seals:

1. Listed as complying with UL 514B.
2. Specifically designed for sealing conduit openings against water, moisture, gases, and dust.
3. Suitable for sealing around conductors/cables to be installed.
4. Products:

    a. American Polywater Corporation; PHRD SG Mechanical Seals: www.polywater-haufftechnik.com/#sle.

    b. Substitutions: See Section 01 60 00 - Product Requirements.

I. Sealing Systems for Concrete Penetrations:

1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
3. Products:

a. American Polywater Corporation; PZVR Cement-Coated Concrete Wall Sleeves: www.polywater-haufftechnik.com/#sle.

b. American Polywater Corporation; PHSD Mechanical Seals: www.polywater-haufftechnik.com/#sle.

c. American Polywater Corporation; PHSI 150 Varia Double Wall Inserts: www.polywater-haufftechnik.com/#sle.

d. American Polywater Corporation; PGKD Modular Seals: www.polywater-haufftechnik.com/#sle.

e. Substitutions: See Section 01 60 00 - Product Requirements.

J. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.

1. Products:

a. Alta Products, LLC; Sigrist Pipe Chase Housing, Curbs, and Exit Seals: www.altaproductsllc.com/#sle.

b. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.

c. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

K. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

1. Products:

a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.

L. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

1. Products:

a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

M. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.

1. Products:

a. Advance Products & Systems, LLC; Duct Bank Spacers: www.apsonline.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

N. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for casing and conduit/duct arrangement to be installed.

1. Products:

a. Advance Products & Systems, LLC; Bore Spacers: www.apsonline.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install conduit in accordance with NECA 1.

C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.

D. Aluminum Rigid Metal Conduit (RMC): Install in accordance with NECA 102.

E. Intermediate Metal Conduit (IMC): Install in accordance with NECA 101.

F. PVC-Coated Galvanized Steel Rigid Metal Conduit (RMC): Install using only tools approved by manufacturer.

G. Rigid Polyvinyl Chloride (PVC) Conduit: Install in accordance with NECA 111.

H. Liquidtight Flexible Nonmetallic Conduit (LFNC): Install in accordance with NECA 111.

I. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated without specific routing, determine exact routing required.
3. Conceal conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:

a. Electrical rooms.

b. Mechanical equipment rooms.

c. Within joists in areas with no ceiling.

5. Unless otherwise approved, do not route exposed conduits:
    a. Across floors.
    b. Across roofs.
    c. Across top of parapet walls.
    d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
9. Arrange conduit to provide no more than 150 feet (46 m) between pull points.
10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches (300 mm) between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
14. Group parallel conduits in same area on common rack.

J. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.

7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
9. Use of spring steel conduit clips for support of conduits is permitted only as follows:
    a. Support of electrical metallic tubing (EMT) up to 1-inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
10. Use of wire for support of conduits is not permitted.
11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

K. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
8. Secure joints and connections to provide mechanical strength and electrical continuity.

L. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
8. Provide metal escutcheon plates for conduit penetrations exposed to public view.

9. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.

M. Underground Installation:

1. Provide trenching and backfilling; see Section 31 23 16.13.
2. Minimum Cover, Unless Otherwise Indicated or Required:
    a. Underground, Exterior: 18 inches (460 mm).
    b. Under Slab on Grade: 4 inches (100 mm) to bottom of slab.
3. Provide underground warning tape along entire conduit length for service entrance where not concrete-encased; see Section 26 05 53.

N. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):

1. Maximum Conduit Size: 1-inch (27 mm) trade size unless otherwise approved.
2. Minimum Conduit Spacing: 2".
3. Install conduits within middle one third of slab thickness.
4. Secure conduits to prevent floating or movement during pouring of concrete.

O. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide minimum concrete cover of 3 inches (76 mm) on all sides unless otherwise indicated; see Section 03 30 00.

P. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
4. Where conduits are subject to earth movement by settlement or frost.

Q. Conduit Sealing:

1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
    a. Where conduits enter building from outside.
    b. Where service conduits enter building from underground distribution system.
    c. Where conduits enter building from underground.
    d. Where conduits may transport moisture to contact live parts.

2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:

    a. Where conduits pass from outdoors into conditioned interior spaces.

    b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

    c. Where conduits penetrate coolers or freezers.

R. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches (300 mm) at each end.

S. Provide grounding and bonding; see Section 26 05 26.

T. Identify conduits; see Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 05 33.13

SECTION 26 05 33.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).

C. Boxes and enclosures for integrated power, data, and audio/video.

D. Floor boxes.

E. Underground boxes/enclosures.

F. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 07 84 00 - Firestopping.

C. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

E. Section 26 05 29 - Hangers and Supports for Electrical Systems.

F. Section 26 05 33.13 - Conduit for Electrical Systems:

1. Conduit bodies and other fittings.
2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

G. Section 26 05 33.23 - Surface Raceways for Electrical Systems:

1. Accessory boxes designed specifically for surface raceway systems.
2. Lay-in wireways and wiring troughs with removable covers.

H. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

I. Section 26 27 26 - Wiring Devices:

1. Wall plates.
2. Floor box service fittings.
3. Additional requirements for locating boxes for wiring devices.

J. Section 26 28 13 - Fuses: Spare fuse cabinets.

K. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems outlet boxes.

L. Section 33 71 19 - Electrical Underground Ducts, Ductbanks, and Manholes: Concrete manholes for electrical systems.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. SCTE 77 - Specifications for Underground Enclosure Integrity; 2023.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.

C. Samples:

1. Floor Boxes: Provide one sample(s) of each floor box proposed for substitution upon request.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches (1,650 cu cm), Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
5. Use suitable concrete type boxes where flush-mounted in concrete.
6. Use suitable masonry type boxes where flush-mounted in masonry walls.
7. Use raised covers suitable for the type of wall construction and device configuration where required.
8. Use shallow boxes where required by the type of wall construction.
9. Do not use "through-wall" boxes designed for access from both sides of wall.
10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
12. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
13. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
14. Minimum Box Size, Unless Otherwise Indicated:

    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.

    b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.

15. Wall Plates: Comply with Section 26 27 26.
16. Manufacturers:

    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.

    b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.

    c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.

    d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

    e. Thomas & Betts Corporation: www.tnb.com/#sle.

    f. Substitutions: See Section 01 60 00 - Product Requirements.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):

1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
    a. Indoor Clean, Dry Locations: Type 1, painted steel.
    b. Outdoor Locations: Type 3R, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
    a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
    b. Boxes 6 square feet (0.56 sq m) and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
    b. Back Panels: Painted steel, removable.
    c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:
    a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
    c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
    d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.

1. Manufacturers:
    a. Hubbell Incorporated; _____: www.hubbell.com/#sle.
    b. Substitutions: See Section 01 60 00 - Product Requirements.

E. Floor Boxes:

1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
2. Use sheet-steel or cast iron floor boxes within slab above grade.

3. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
4. Manufacturer: Same as manufacturer of floor box service fittings.

F. Underground Boxes/Enclosures:

1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches (300 mm).
4. Provide logo on cover to indicate type of service.
5. Applications:

    a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.

    b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 15 load rating.

    c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.

6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.

    a. Manufacturers:

        1) Hubbell Incorporated; Quazite Products: www.hubbellpowersystems.com/#sle.

        2) MacLean Highline: www.macleanhighline.com/#sle.

        3) Oldcastle Precast, Inc: www.oldcastleprecast.com/#sle.

        4) Substitutions: See Section 01 60 00 - Product Requirements.

    b. Combination fiberglass/polymer concrete boxes/enclosures are not acceptable. Use all-polymer concrete boxes/enclosures.

2.2 ACCESSORIES

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.

1. Manufacturers:

    a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.

    b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:

1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
2. Unless dimensioned, box locations indicated are approximate.
3. Locate boxes as required for devices installed under other sections or by others.

    a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.

    b. Communications Systems Outlets: Comply with Section 27 10 00.

4. Locate boxes so that wall plates do not span different building finishes.
5. Locate boxes so that wall plates do not cross masonry joints.
6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches (150 mm) horizontal separation unless otherwise indicated.
8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches (610 mm) horizontal separation.
9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.

a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches (610 mm) separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.

b. Do not install flush-mounted boxes with area larger than 16 square inches (0.0103 sq m) or such that the total aggregate area of openings exceeds 100 square inches (0.0645 sq m) for any 100 square feet (9.29 sq m) of wall area.

10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:

a. Concealed above accessible suspended ceilings.

b. Within joists in areas with no ceiling.

c. Electrical rooms.

d. Mechanical equipment rooms.

I. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6 mm) or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3 mm) at the edge of the box.

L. Floor-Mounted Cabinets: Mount on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 30 00.

M. Install boxes as required to preserve insulation integrity.

N. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

O. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.

P. Underground Boxes/Enclosures:

1. Install enclosure on gravel base, minimum 6 inches (150 mm) deep.
2. Flush-mount enclosures located in concrete or paved areas.
3. Mount enclosures located in landscaped areas with top at 1 inch (25 mm) above finished grade.
4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

Q. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

S. Close unused box openings.

T. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

U. Provide grounding and bonding in accordance with Section 26 05 26.

V. Identify boxes in accordance with Section 26 05 53.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 05 33.16

SECTION 26 05 33.23 - SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface raceway systems.

B. Wireways.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 33.13 - Conduit for Electrical Systems.

D. Section 26 05 33.16 - Boxes for Electrical Systems.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 27 23 - Indoor Service Poles.

G. Section 26 27 26 - Wiring Devices: Receptacles.

H. Section 27 10 00 - Structured Cabling: Voice and data jacks.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NEMA BI 50061 - Installation Guidelines for Surface and Nonmetallic Raceway; 2021 (Reapproved 2025).

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.

F. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.

G. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.

2. Coordinate rough-in locations of outlet boxes provided under Section 26 05 33.16 and conduit provided under Section 26 05 33.13 as required for installation of raceways provided under this section.
3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install raceways until final surface finishes and painting are complete.
2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.

1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

C. Shop Drawings:

1. Pre-wired Surface Raceway Systems: Provide plan and elevation views including dimensioned locations of wiring devices and circuiting arrangements.
2. Wireways: Provide dimensioned plan and elevation views including adjacent equipment with all required clearances indicated.

D. Samples: Three of each type and color of surface raceway system specified, 6 inches (150 mm) in length.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 RACEWAY REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.2 SURFACE RACEWAY SYSTEMS

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell.com/#sle.
2. Legrand North America, Inc: www.legrand.us/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Surface Metal Raceways: Listed and labeled as complying with UL 5.

C. Multioutlet Assemblies: Listed and labeled as complying with UL 111.

D. Surface Raceway System:

1. Raceway Type: Two channel, painted steel.
2. Length: As indicated on the drawings.
3. Color: To be selected by Architect.
4. Accessory Device Boxes: Suitable for the devices to be installed; color to match raceway.
5. Integrated Device Provisions:

a. Receptacles:

1) Comply with Section 26 27 26, except for finishes.

2) Configuration: As indicated on the drawings.

3) Color: Match raceway.

4) Spacing: As indicated on the drawings.

b. Communications Outlets:

1) Voice and Data Jacks: As specified in Section 27 10 00.

2) Configuration: As indicated on the drawings.

3) Spacing: As indicated on the drawings.

6. Products:

a. Hubbell IncorporateD.

b. Legrand North America, Inc.

c. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 WIREWAYS

A. Manufacturers:

1. Eaton Corporation: www.eaton.com/#sle.
2. Enduro Composites: www.endurocomposites.com/#sle.
3. nVent HOFFMAN: www.nvent.com/#sle.
4. Schneider Electric: www.se.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.

C. Wireway Type, Unless Otherwise Indicated:

1. Indoor Clean, Dry Locations: NEMA EN 10250, Type 1, painted steel with screw-cover.
2. Outdoor Locations: NEMA EN 10250, Type 3R, painted steel with screw-cover; include provision for padlocking.

D. Finish for Painted Steel Wireways: Manufacturer's standard grey unless otherwise indicated.

E. Minimum Wireway Size: 4 by 4 inches (100 by 100 mm) unless otherwise indicated.

F. Where wireway size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.

C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Surface Nonmetallic Raceways: Install in accordance with NEMA BI 50061.

D. Install raceways plumb and level.

E. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.

F. Secure and support raceways in accordance with Section 26 05 29 at intervals complying with NFPA 70 and manufacturer's requirements.

G. Close unused raceway openings.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Identify raceways in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect raceways for damage and defects.

C. Surface Raceway Systems with Integrated Devices: Test each wiring device to verify operation and proper polarity.

D. Correct wiring deficiencies and replace damaged or defective raceways.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 PROTECTION

A. Protect installed raceways from subsequent construction operations.

END OF SECTION 26 05 33.23

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Floor marking tape.

G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Section 09 91 13 - Exterior Painting.

B. Section 09 91 23 - Interior Painting.

C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

D. Section 26 05 36 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.

E. Section 26 05 73 - Power System Studies: Arc flash hazard warning labels.

F. Section 26 23 00 - Low-Voltage Switchgear: Factory-installed mimic bus.

G. Section 26 27 26 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.

H. Section 27 10 00 - Structured Cabling: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

D. Samples:

1. Identification Nameplates: One of each type and color specified.
2. Warning Signs and Labels: One of each type and legend specified.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.

a. Switchgear:

1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Use identification nameplate to identify main and tie devices.

5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

b. Switchboards:

1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Use identification nameplate to identify main overcurrent protective device.
5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

c. Panelboards:

1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

d. Transformers:

1) Identify kVA rating.
2) Identify voltage and phase for primary and secondary.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

e. Enclosed switches, circuit breakers, and motor controllers:

1) Identify voltage and phase.
2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.

f. Time Switches:

1) Identify load(s) served and associated circuits controlled. Include location.

g. Enclosed Contactors:

1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).

4) Identify coil voltage.

5) Identify load(s) and associated circuits controlled. Include location.

h. Centralized Emergency Lighting Inverters:

1) Identify input and output voltage and phase.

2) Identify power source and circuit number for normal power source. Include location when not within sight of equipment.

3) Identify load(s) served. Include location.

i. Transfer Switches:

1) Identify voltage and phase.

2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.

3) Identify load(s) served. Include location when not within sight of equipment.

4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

j. Electricity Meters:

1) Identify load(s) metered.

2. Service Equipment:

a. Use identification nameplate to identify each service disconnecting means.

b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

3. Emergency System Equipment:

a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.

b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.

c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.

4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
6. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
7. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
8. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
9. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.

    a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches (76 mm) wide, painted in accordance with Section 09 91 23 and 09 91 13.

10. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.

    a. Service equipment.

    b. Industrial control panels.

    c. Motor control centers.

    d. Elevator control panels.

    e. Industrial machinery.

11. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.
12. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
13. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
14. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
15. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

B. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.
3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
    a. At each source and load connection.
    b. Within boxes when more than one circuit is present.
    c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
    d. In cable tray, at maximum intervals of 20 feet (6.1 m).
5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
6. Use underground warning tape to identify direct buried cables.

C. Identification for Raceways:

1. Use voltage markers, color-coded bands, or factory-painted conduits to identify systems other than normal power system for accessible conduits.
    a. Maximum Intervals: 20 feet (6.1 m).
    b. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches (76 mm) wide.
        1) Field-Painting: Comply with Section 09 91 23 and 09 91 13.
        2) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.
    c. Color Code:
        1) Emergency Power System: Red.
            (a) Life Safety Branch: _____.
            (b) Equipment Branch: _____.
        2) Fire Alarm System: Red.
2. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
3. Use underground warning tape to identify underground raceways.

D. Identification for Cable Tray: Comply with Section 26 05 36.

E. Identification for Boxes:

1. Use voltage markers to identify highest voltage present.

2. Use voltage markers or color coded boxes to identify systems other than normal power system.

    a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 and 09 91 13 per the same color code used for raceways.

        1) Emergency Power System: Red.

            (a) Life Safety Branch: _____.
            (b) Equipment Branch: _____.

        2) Fire Alarm System: Red.

    b. For exposed boxes in public areas, do not color code.

3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

    a. For exposed boxes in public areas, use only identification labels.

4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

F. Identification for Devices:

1. Identification for Communications Devices: Comply with Section 27 10 00.
2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
3. Use identification label to identify fire alarm system devices.
4. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:

    a. Indoor Clean, Dry Locations: Use plastic nameplates.

    b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.

2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch (1.6 mm); engraved text.

    a. Exception: Provide minimum thickness of 1/8 inch (3 mm) when any dimension is greater than 4 inches (100 mm).

3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.

5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:

a. Brady Corporation; _____: www.bradyid.com/#sle.

b. Panduit Corp: www.panduit.com/#sle.

c. Substitutions: See Section 01 60 00 - Product Requirements.

2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.

a. Use only for indoor locations.

3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
2. Legend:

a. System designation where applicable:

1) Emergency Power System: Identify with text "EMERGENCY".

2) Fire Alarm System: Identify with text "FIRE ALARM".

b. Equipment designation or other approved description.

3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:

a. System Designation: 1 inch (25 mm).

b. Equipment Designation: 1/2 inch (13 mm).

c. Other Information: 1/4 inch (6 mm).

d. Exception: Provide minimum text height of 1 inch (25 mm) for equipment located more than 10 feet (3.0 m) above floor or working platform.

5. Color:

a. Normal Power System: White text on black background.

1) 480Y/277 V, 3 Phase Equipment: White text on _____ background.

2) 208Y/120 V, 3 Phase Equipment: White text on _____ background.

b. Emergency Power System: White text on red background.

1) Life Safety Branch: White text on _____ background.

2) Equipment Branch: White text on _____ background.

c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:

1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch (6 mm).
5. Color: Black text on white background unless otherwise indicated.

a. Exceptions:

1) Provide white text on red background for general information or operational instructions for emergency systems.

2) Provide white text on red background for general information or operational instructions for fire alarm systems.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches (51 mm) by 4 inches (100 mm).
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch (13 mm).
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
2. Legend: Power source and circuit number or other designation indicated.

a. Include voltage and phase for other than 120 V, single phase circuits.

3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch (5 mm).
5. Color: Black text on clear background.

G. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch (5 mm).
5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:

1. Brady Corporation; _____: www.bradyid.com/#sle.

2. HellermannTyton; _____: www.hellermanntyton.com/#sle.
3. Panduit Corp: www.panduit.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

1. Do not use handwritten text.

F. Minimum Text Height: 1/8 inch (3 mm).

G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

A. Manufacturers:

1. Brady Corporation; _____: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Seton Identification Products; _____: www.seton.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

D. Minimum Size:

1. Markers for Equipment: 1 1/8 by 4 1/2 inches (29 by 110 mm).
2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches (29 by 110 mm).
4. Markers for Junction Boxes: 1/2 by 2 1/4 inches (13 by 57 mm).

E. Legend:

1. Markers for Voltage Identification: Highest voltage present.
2. Markers for System Identification:

a. Emergency Power System: Text "EMERGENCY".

F. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:

1. Brady Corporation; _____: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Seton Identification Products; _____: www.seton.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Foil-backed Detectable Type Tape: 3 inches (76 mm) wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color:

1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 FLOOR MARKING TAPE

A. Manufacturers:

1. Brady Corporation; _____: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Insite Solutions, LLC; _____: www.stop-painting.com/#sle.
4. Seton Identification Products; _____: www.seton.com/#sle.

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches (76 mm) wide, with alternating black and white stripes.

2.7 WARNING SIGNS AND LABELS

A. Manufacturers:

1. Brimar Industries, Inc: www.brimar.com/#sle.
2. Clarion Safety Systems, LLC; _____: www.clarionsafety.com/#sle.
3. Insite Solutions, LLC; _____: www.stop-painting.com/#sle.
4. Seton Identification Products; _____: www.seton.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:

1. Materials:

a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.

b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.

2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
3. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.

D. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.

a. Do not use labels designed to be completed using handwritten text.

2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

E. Floor Signs:

1. Materials: Use factory preprinted, self-adhesive vinyl, polyester, or rubber labels with protective overlaminate; removable.
2. Minimum Size: 17-inch (430 mm) diameter unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches (75 mm) below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26 05 53

SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Short-circuit study.

B. Protective device coordination study.

C. Arc flash and shock risk assessment.

1. Includes arc flash hazard warning labels.

D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.2 RELATED REQUIREMENTS

A. Section 26 05 53 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

B. Section 26 13 00 - Medium-Voltage Switchgear.

C. Section 26 21 00 - Low-Voltage Electrical Service Entrance.

1. Includes Utility Company contact information.

D. Section 26 23 00 - Low-Voltage Switchgear.

E. Section 26 24 13 - Switchboards.

F. Section 26 28 13 - Fuses.

G. Section 26 28 16.13 - Enclosed Circuit Breakers.

H. Section 26 28 16.16 - Enclosed Switches.

I. Section 26 29 13 - Enclosed Controllers.

1.3 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2023.

B. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).

C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).

D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.

F. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations; 2018, with Errata (2019).

G. NEMA MG 00001 - Motors and Generators; 2024.

H. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
2. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Pre-Study Meeting: Conduct meeting with Owner to discuss system operating modes and conditions to be considered in studies.

C. Sequencing:

1. Submit study reports prior to or concurrent with product submittals.
2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Study preparer's qualifications.

C. Field testing agency's qualifications.

D. Study reports, stamped or sealed and signed by study preparer.

E. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.

1. Include characteristic time-current trip curves for protective devices.
2. Include impedance data for engine generators.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Include documentation of listed series ratings upon request.
5. Identify modifications made in accordance with studies that:

a. Can be made at no additional cost to Owner.

b. As submitted will involve a change to the contract sum.

F. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

G. Site-specific arc flash hazard warning labels.

H. Field quality control reports.

I. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

J. Project Record Documents: Revise studies as required to reflect as-built conditions.

1. Include hard copies with operation and maintenance data submittals.
2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.6 POWER SYSTEM STUDIES

A. Scope of Studies:

1. Perform analysis of new electrical distribution system as indicated on drawings.
2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.

a. Known Operating Modes:

1) Utility as source.

2) Generator as source.

B. General Study Requirements:

1. Comply with NFPA 70.
2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:

1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.

a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.

1) Obtain up-to-date information from Utility Company.

2) Utility Company: UNIVERSITY OF MAINE.

(a) Point of Contact: BLAINE WILLIAMS.
(b) Email: BLAINE.WILLIAMS@MAINE.EDU.

b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.

c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 00001 code letter designation.

d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.

e. Protective Devices:

1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).

2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).

f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.

g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:

1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:

a. Maximum utility fault currents.

b. Maximum motor contribution.

c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:

1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

3. Analyze protective devices and associated settings for suitable margins between time-current curves to provide adequate protection for equipment and conductors while achieving full selective coordination.

F. Arc Flash and Shock Risk Assessment:

1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.

a. Where reasonable, study preparer may assume a maximum clearing time of two seconds in accordance with IEEE 1584, provided that the conditions are such that a worker's egress from an arc flash event would not be inhibited.

b. For single-phase systems, study preparer to perform calculations assuming three-phase system in accordance with IEEE 1584 using single phase bolted fault current, yielding conservative results.

3. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.
4. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:

a. Maximum and minimum utility fault currents.

b. Maximum and minimum motor contribution.

c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:

1. General Requirements:

a. Identify date of study and study preparer.

b. Identify study methodology and software product(s) used.

c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.

d. Identify base used for per unit values.

e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.

f. Include conclusions and recommendations.

2. Short-Circuit Study:

a. For each scenario, identify at each bus location:

1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).

2) Fault point X/R ratio.

3) Associated equipment short circuit current ratings.

b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.

3. Protective Device Coordination Study:

a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.

b. For each graph include (where applicable):

1) Partial single-line diagram identifying the portion of the system illustrated.

2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.

3) Conductors: Damage curves.

4) Transformers: Inrush points and damage curves.

5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.

6) Motors: Full load current, starting curves, and damage curves.

7) Capacitors: Full load current and damage curves.

c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.

1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.

2) Include ground fault pickup and delay.

3) Include fuse ratings.

4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.

d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

4. Arc Flash and Shock Risk Assessment:

a. For the worst case for each scenario, identify at each bus location:

1) Calculated incident energy and associated working distance.

2) Calculated arc flash boundary.

3) Bolted fault current.

4) Arcing fault current.

5) Clearing time.

6) Arc gap distance.

b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

c. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq cm.

1.7 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in preparation of studies of similar type and complexity using specified computer software.

1. Study preparer may be employed by manufacturer of electrical distribution equipment.
2. Study preparer may be employed by field testing agency.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

1. Products:

a. SKM Systems Analysis, Inc: www.skm.com/#sle.

PART 2 PRODUCTS

2.1 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

1. Materials: Comply with Section 26 05 53.
2. Minimum Size: 4 by 6 inches (100 by 150 mm).
3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.

a. Include orange header that reads "WARNING" unless otherwise indicated.

b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.

c. Include the following information:

1) Arc flash boundary.

2) Available incident energy and corresponding working distance.

3) Site-specific PPE (personnel protective equipment) requirements.

4) Nominal system voltage.

5) Limited approach boundary.

6) Restricted approach boundary.

7) Equipment identification.

8) Study preparer, report reference, and date calculations were performed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install arc flash warning labels in accordance with Section 26 05 53.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Adjust equipment and protective devices for compliance with studies and recommended settings.

E. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.

F. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.3 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Training: Include as part of the base bid training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.

1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.
2. Provide minimum of eight hours of training.
3. Instructor: Representative of entity performing study.
4. Location: At project site.

END OF SECTION 26 05 73

SECTION 26 05 83 - WIRING CONNECTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26 05 33.13 - Conduit for Electrical Systems.

C. Section 26 05 33.16 - Boxes for Electrical Systems.

D. Section 26 27 26 - Wiring Devices.

E. Section 26 28 16.16 - Enclosed Switches.

F. Section 26 29 13 - Enclosed Controllers.

1.3 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).

B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
2. Determine connection locations and requirements.

B. Sequencing:

1. Install rough-in of electrical connections before installation of equipment is required.
2. Make electrical connections before required start-up of equipment.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

1. Colors: Comply with NEMA WD 1.
2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

B. Disconnect Switches: As specified in Section 26 28 16.16 and in individual equipment sections.

C. Wiring Devices: As specified in Section 26 27 26.

D. Flexible Conduit: As specified in Section 26 05 33.13.

E. Wire and Cable: As specified in Section 26 05 19.

F. Boxes: As specified in Section 26 05 33.16.

2.2 EQUIPMENT CONNECTIONS

A. AS INDICTED ON THE DRAWINGS:

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION 26 05 83

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Occupancy sensors.

B. Outdoor motion sensors.

C. Time switches.

D. In-wall time switches.

E. In-wall interval timers.

F. Outdoor photo controls.

G. Digital load controllers.

H. Emergency lighting control devices.

I. Lighting contactors.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems

D. Section 26 05 33.16 - Boxes for Electrical Systems.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 05 73 - Power System Studies.

G. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.

1. Includes finish requirements for wall controls specified in this section.
2. Includes accessory receptacles, switches, dimmers and wall plates, to match lighting controls specified in this section.

H. Section 26 28 13 - Fuses.

I. Section 26 29 13 - Enclosed Controllers : General purpose contactors.

J. Section 26 51 00 - Interior Lighting.

K. Section 26 56 00 - Exterior Lighting.

L. Section 28 46 00 - Fire Detection and Alarm.

1.3 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.

B. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing; 2023.

C. ANSI C136.24 - American National Standard for Roadway and Area Lighting Equipment—Nonlocking (Button)–Type Photocontrols; 2026.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.

F. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2023.

H. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

I. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.

J. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.

M. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

N. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

O. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

P. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

Q. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

R. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

S. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.

T. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.

U. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate placement of lighting control devices with millwork, furniture, equipment and other potential conflicts.
2. Coordinate placement of wall switch occupancy sensors with installed door swings.
3. Coordinate placement of occupancy sensors with millwork, furniture, equipment and other potential obstructions to motion detection coverage.
4. Coordinate placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement.
5. Coordinate lighting control device product selections with luminaire characteristics; see Section 26 51 00 and lighting fixture schedule.
6. Notify Architect of conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include ratings, operating modes or sequence of functions, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:

1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
2. Digital Load Controllers: Provide dimensioned plan views indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections. Include manufacturer product characteristics and application instructions for wired and wireless applications, including start-up and commissioning.
3. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.

D. Samples:

1. Occupancy Sensors: One for each type and color specified.
2. In-Wall Time Switches: One for each type and color specified.
3. In-Wall Interval Timers: One for each type and color specified.
4. Daylighting Control Photo Sensors: One for each type and color specified.

E. Field quality control reports.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include detailed information on device programming and setup.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Extra Locking Receptacle-Mounted Outdoor Photo Controls: Five percent of total quantity installed for each type, but not less than two of each type.

I. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Maintain at project site one copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

D. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as Nationally Recognized Testing Laboratories (NRTL), and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store products in clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for duration below. Complete forms in Owner's name and register with manufacturer.

1. Occupancy Sensors: 5 years.
2. Utility Grade Locking Receptacle-Mounted Outdoor Photo Controls: 5 years.
3. Digital Load Controllers: 5 years.
4. Emergency Lighting Control Devices: 5 years.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for purpose intended.

B. Unless specifically indicated as excluded, provide components necessary for complete operating system including, but not limited to, conduit, wiring, connectors, hardware, and accessories.

2.2 OCCUPANCY SENSORS

A. Manufacturers:

1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
2. Hubbell Incorporated: www.hubbell.com/#sle.
3. Legrand North America, Inc: www.legrand.us/#sle.
4. Lutron Electronics Company, Inc: www.lutron.com/#sle.
5. RAB Lighting, Inc: www.rablighting.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.
7. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

B. General Requirements:

1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
2. Sensor Technology:

a. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using combination of both passive infrared and ultrasonic technologies.

b. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using combination of both passive infrared and audible sound sensing technologies.

3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during adjustable turn-off delay time interval.
5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
8. Sensitivity: Field adjustable.

9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
10. Integral Photocell: For field selectable and adjustable inhibition of automatic turn-on of load when ambient lighting is above selected level.
11. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
12. Load Rating for Line Voltage Occupancy Sensors: As required to control load indicated on drawings.
13. Load Rating for Line Voltage Occupancy Sensors:
    a. Incandescent Load: Not less than 800 W.
    b. Fluorescent Load: Not less than 800 W at 120 V ac and 1,200 W at 277 V ac.
    c. Motor Load: Not less than 1/6 HP.
14. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

C. Wall Switch Occupancy Sensors:

1. General Requirements:
    a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
    b. Unless otherwise indicated or required to control load indicated on drawings, provide line voltage units with self-contained relay.
    c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
    d. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
    e. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during delayed-off time interval.
    f. Provide selectable audible alert to notify occupant of impending load turn-off.
    g. Finish: Match finishes specified for wiring devices in Section 26 27 26, unless otherwise indicated.
2. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within area of 900 square feet (83.6 sq m).

D. Wall Dimmer Occupancy Sensors:

1. General Requirements:

a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.

b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).

c. Manual-Off Override Control Capability: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during delayed-off time interval.

d. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.

e. Provide field adjustable dimming preset for occupied state.

f. Provide fade-to-off operation to notify occupant of impending load turn-off.

g. Finish: Match finishes specified for wiring devices in Section 26 27 26, unless otherwise indicated.

E. Ceiling Mounted Occupancy Sensors:

1. General Requirements:

a. Description: Low profile occupancy sensors designed for ceiling installation.

b. Unless otherwise indicated or required to control load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.

c. Provide field selectable setting for disabling LED motion detector visual indicator.

d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.

e. Finish: White unless otherwise indicated.

2. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:

a. Standard Range Sensors: Capable of detecting motion within area of 450 square feet (41.8 sq m) at mounting height of 9 feet (2.7 m), with field of view of 360 degrees.

b. Extended Range Sensors: Capable of detecting motion within area of 1,200 square feet (111.5 sq m) at mounting height of 9 feet (2.7 m), with field of view of 360 degrees.

3. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:

a. Standard Range Sensors: Capable of detecting motion within area of 450 square feet (41.8 sq m) at mounting height of 9 feet (2.7 m), with field of view of 360 degrees.

b. Extended Range Sensors: Capable of detecting motion within area of 1,200 square feet (111.5 sq m) at mounting height of 9 feet (2.7 m).

F. Directional Occupancy Sensors:

1. General Requirements:

a. Description: Occupancy sensors designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.

b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.

c. Provide field selectable setting for disabling LED motion detector visual indicator.

d. Finish: White unless otherwise indicated.

2. Passive Infrared/Ultrasonic Dual Technology Directional Occupancy Sensors: Capable of detecting motion within distance of 40 feet (12 m) at mounting height of 10 feet (3.1 m).

G. Luminaire Mounted Occupancy Sensors: Designed for direct luminaire installation and control, suitable for use with specified luminaires.

H. Power Packs for Low-Voltage Occupancy Sensors:

1. Description: Plenum rated, self-contained low-voltage class 2 transformer and relay compatible with specified low-voltage occupancy sensors for switching of line-voltage loads.
2. Provide quantity and configuration of power and slave packs with associated wiring and accessories as required to control load indicated on drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating: As required to control load indicated on drawings.

I. Power Packs for Wireless Occupancy Sensors:

1. Description: Plenum rated, self-contained relay compatible with specified wireless occupancy sensors for switching of line-voltage loads.
2. Input Supply Voltage: Dual rated for 120/277 V ac.
3. Load Rating: As required to control load indicated on drawings.
4. Rated Life of Relay: One million cycles.

2.3 OUTDOOR MOTION SENSORS

A. Manufacturers:

1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
2. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
3. Legrand North America, Inc: www.legrand.us/#sle.

4. RAB Lighting, Inc: www.rablighting.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.
6. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

B. Description: Factory-assembled wet location listed device suitable for wall or ceiling/eave mounting, with integral swivel for field adjustment of coverage, capable of detecting motion for automatic control of load indicated.

C. Sensor Technology: Passive Infrared (PIR) designed to detect occupancy by sensing movement of thermal energy between zones.

D. Operation: Unless otherwise indicated, motion sensor to turn load on when motion is detected and to turn load off when no motion is detected during adjustable turn-off delay time interval.

E. Turn-Off Delay: Field adjustable, with time delay settings available up to 15 minutes.

F. Integral Photocell: For dusk to dawn operation.

G. Manual Override: Activated by switching power off to unit and then back on.

H. Load Rating: 1,000 W incandescent and fluorescent load at 120 V ac.

I. Coverage: Capable of detecting motion within distance of 50 feet (15 m) at mounting height of 8 feet (2.4 m), with field of view of 270 degrees.

J. Finish: Color to be selected.

2.4 TIME SWITCHES

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com/#sle.
2. NSI Industries LLC: www.nsiindustries.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.
4. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

B. Digital Electronic Time Switches:

1. Description: Factory-assembled solid state programmable controller with LCD display, listed and labeled as complying with UL 916 or UL 917.
2. Program Capability:

a. Astronomic Time Switches: Single channel, capable of different schedule for each day of week with additional holiday schedule available to override normal schedule for selected days and field-configurable astronomic feature to automatically adjust for seasonal changes in sunrise and sunset times.

3. Schedule Capacity: Not less than 16 programmable on/off operations.
4. Provide automatic daylight savings time and leap year compensation.
5. Provide power outage backup to retain programming and maintain clock.

6. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
7. Provide remote photocell input with light level adjustment.
8. Input Supply Voltage: As indicated on the drawings.
9. Output Switch Configuration: As required to control load indicated on drawings.
10. Output Switch Contact Ratings: As required to control load indicated on drawings.
11. Provide lockable enclosure; environmental type per NEMA EN 10250 as specified for the following installation locations:

    a. Indoor clean, dry locations: Type 1.

    b. Outdoor locations: Type 3R.

2.5 IN-WALL TIME SWITCHES

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com/#sle.
2. NSI Industries LLC: www.nsiindustries.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.
4. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

B. Digital Electronic In-Wall Time Switches:

1. Description: Factory-assembled solid state programmable controller with LCD display, suitable for mounting in standard wall box, and listed and labeled as complying with UL 916 or UL 917.
2. Program Capability:

    a. Astronomic Time Switches: Capable of different schedule for each day of week and field-configurable astronomic feature to automatically adjust for seasonal changes in sunrise and sunset times.

3. Schedule Capacity: Not less than 40 programmable on/off operations.
4. Provide automatic daylight savings time compensation.
5. Provide power outage backup to retain programming and maintain clock.
6. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
7. Switch Configuration: Suitable for use in either SPST or 3-way application.
8. Contact Ratings: As required to control load indicated on drawings.

2.6 IN-WALL INTERVAL TIMERS

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com/#sle.
2. NSI Industries LLC: www.nsiindustries.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Digital Electronic In-Wall Interval Timers:

1. Description: Factory-assembled solid state programmable controller with LCD display, suitable for mounting in standard wall box, and listed and labeled as complying with UL 916 or UL 917.
2. Program Capability: Designed to turn load off at end of preset time interval.
3. Time Interval: Field selectable range of presets available up to 12 hours.
4. Provide field selectable audible and visual indication to warn that end of interval operation is about to turn off load.
5. Provide power outage backup to retain programming and maintain clock.
6. Manual override: Capable of both turning load off and resetting timer to original preset time interval.
7. Switch Configuration: Suitable for use in either SPST or 3-way application.
8. Contact Ratings: As required to control load indicated on drawings.

2.7 OUTDOOR PHOTO CONTROLS

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com/#sle.
2. NSI Industries LLC: www.nsiindustries.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.
4. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

B. Stem-Mounted Outdoor Photo Controls:

1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
2. Housing: Weatherproof, impact resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Provide external sliding shield for field adjustment of light level activation.
5. Light Level Activation: 1 to 5 footcandles (10.8 to 53.8 lux) turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
6. Voltage: As required to control load indicated on drawings.
7. Failure Mode: Fails to the on position.
8. Load Rating: As required to control load indicated on drawings.

C. Locking Receptacle-Mounted Outdoor Photo Controls

1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on compatible receptacle, listed and labeled as complying with UL 773.
2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles (10.8 to 32.3 lux) turn-on and 1.5 to 1 turn-off to turn-on ratio with instant turn-on and delayed turn-off.
5. Voltage: As required to control load indicated on drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control load indicated on drawings.
8. Surge Protection: 160 joule metal oxide varistor.

D. Button Type Outdoor Photo Controls

1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
2. Housing: Weather resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles (10.8 to 32.3 lux) turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
5. Voltage: As required to control load indicated on drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control load indicated on drawings.

2.8 DIGITAL LOAD CONTROLLERS

A. Manufacturers:

1. Hubbell Control Solutions: www.hubbell.com/hubbellcontrolsolutions/en/#sle.
2. Intermatic, Inc: www.intermatic.com/#sle.
3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
4. WattStopper: www.wattstopper.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.
6. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

B. System Description:

1. Stand-alone system, including interconnected modules and accessories, for lighting and plug load low-voltage control as indicated on drawings, schedules, written sequences of operation, and reviewed shop drawings.
2. Product standard system configurations preconfigured out of box, plug-and-play, automatically self-addressing devices for communications, and without need to field configure or program features, or requiring device setting adjustments. LEDs on unit indicate operation and troubleshooting without software intervention.
3. Provide quantity and configuration of power and slave packs, communication modules, and load expansion modules, including associated wiring, wired and wireless components, and accessories to control loads indicated.
4. Also referred to as room, area, or architectural digital load controllers, as indicated, depending on space and functionality. Each controller includes one or more channels for load control, also referred to as zones.
5. Provide networkable digital load controllers and system components for future integration of luminaires and devices.

C. General Requirements:

1. Listed for powering and controlling line-voltage loads, power packs, contactors, relays, and other lighting control devices.

a. UL 916 listed for energy management.

b. Design Lighting Consortium (DLC) listed.

c. Damp location rated where required by NFPA 70.

2. Input Supply Voltage: Dual rated for 120/277 VAC.
3. Cabling Terminations:

a. Provide field fabricated, and tested before installation, control wiring.

b. Include two RJ 45 or mechanical screw-based terminal block wiring connections.

4. Compatibility:

a. Compatible with luminaires specified with integral sensors; include auxiliary contact closure accessory components for controls indicated.

b. Compatible with wired and wireless sensors and communication protocols for controlling line-voltage loads.

1) Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.

c. Configurable for single room control as indicated from single digital load controller.

5. Provide UL 2043 plenum rated control unit with self-contained relay(s) and low-voltage class 2 transformer, compatible with specified wired and wireless sensors, components, and ballasts/drivers.

a. Comply with NFPA 70 for use in plenum spaces.

b. Provide UL 2043 plenum rating for associated system control components for control indicated.

6. Surface Mounting: Standard junction box attachments.
7. Provide one auxiliary contact closure output where indicated.
8. Minimum Load Rating: As required to control load indicated on drawings.
9. Control Inputs:

a. Digital: Two.

b. Analog: One.

c. Include 24 VDC device power input and coordinate maximum current draw as required.

d. Include automatic-on and manual-on occupancy control wiring inputs.

e. Include wiring inputs for manual overrides as indicated.

10. Output Control Capability:

a. Single Zone Switching Modules: One programmable channel.

b. Multi-Zone Switching Modules: Up to three separately programmable channels.

c. Channel Dimming as Indicated:

1) Range: From 1 percent to 100 percent, allowing for precise control of light levels.

2) Method: 0-10 VDC protocol; coordinate maximum current draw as required.

D. Additional Integrated Requirements forDigital Load Controllers:

1. Central Monitoring and Management: Include programmable user interface for lighting system controllable features; control access locally by plugging into devices and LAN network via browser-based software with settings retained in nonvolatile memory.
2. Provide additional auxiliary contact closure outputs where required for functions and operating modes indicated.
3. Scheduling:

a. Include timer and clock configurator for full calendar year and daylight savings automatic adjustments based on time zone.

b. Provide function for hold-on, designed within time limitations or other restrictions of presiding energy code.

c. Demand Response: Load shed or hold-off capability.

4. Occupancy Controls:

a. Scene Control: Occupant selections by lighting control devices for controls as indicated.

b. Bi-level Switching: Multi-level lighting for controls as indicated.

c. Dimming: Occupancy controlled dimming, including blink warning; 50 percent light-level after programmed delay time.

d. Shade Control: Interfacing capability.

5. Energy Monitoring:

a. Include capability for integration with power monitoring system via BACnet/IP communications.

b. Include reporting and exporting in spreadsheet and PDF file formats.

6. Daylight Harvesting:

a. System Description:

1) Control system with compatible control modules, power packs, contactors, or relays as required for automatic control of load indicated according to available natural light.

2) System control responds to changes in measured light levels according to selected settings.

3) Capable of integrating with daylighting sensors, occupancy sensors, and manual override controls.

b. Daylighting Control Photo Sensors: Low-voltage class 2 photo sensor units with output signal proportional to measured light level and provision for zero or offset based signal.

1) Sensor Type: Filtered silicon photo diode.

2) Sensor Range:

(a) Indoor Photo Sensors: 5 to 100 footcandles (53.8 to 1,080 lx).

3) Finish: White unless otherwise indicated.

4) Where wired sensors are indicated, wireless sensors are acceptable provided that components and wiring modifications necessary for proper operation are included.

5) Wireless Daylighting Control Photo Sensors:

(a) RF Range: 30 feet (9 m) through typical construction materials.
(b) Power: Battery-operated with minimum ten-year battery life.

c. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts/drivers, for direct continuous dimming of up to 50 ballasts/drivers.

d. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.

e. Daylight Control Switching Modules: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with no-switching dead band between set points to prevent unwanted cycling.

f. Daylight Control Dimming Module Operation:

1) Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.

2) Load to be turned off when available daylight is sufficient to fully dim load, after selected time delay.

3) Dimming and Fade Rates: Adjustable from 5 to 60 seconds.

4) Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.

5) Output Voltage: Compatible with specified dimming ballasts/drivers.

2.9 EMERGENCY LIGHTING CONTROL DEVICES

A. Automatic Load Control Relays:

1. Listed and labeled as complying with UL 924.
2. Bypass/shunt lighting controls upon loss of normal power source to turn controlled emergency lighting loads on at full light output.

B. Branch Circuit Emergency Lighting Transfer Switches (BCELTS):

1. Listed and labeled as complying with UL 1008.
2. Transfer controlled emergency lighting loads from normal power source to emergency power source.

C. Devices Installed in Spaces Used for Environmental Air: Plenum rated, suitable for use in air-handling spaces; listed and labeled as complying with UL 2043.

D. Provide integral fire alarm interface to activate emergency mode via signal from fire alarm panel.

1. See Section 28 46 00.

E. Provide compatible listed accessory remote test switch where indicated on drawings.

2.10 LIGHTING CONTACTORS

A. Description: Magnetic lighting contactors complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; noncombination type unless otherwise indicated; ratings, configurations and features as indicated on drawings.

B. Combination Contactors: NEMA ICS 2, Class A combination controllers with magnetic contactors and externally operable disconnect.

1. Disconnects: Circuit breaker or disconnect switch type as indicated.

a. Disconnect Switches: Fusible type unless otherwise indicated.

b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening cover with disconnect in the ON position with capability of overriding interlock for testing purposes.

c. Provide auxiliary interlock for disconnection of external control power sources where applicable.

C. Short Circuit Current Rating:

1. Provide contactors with listed short circuit current rating not less than available fault current at installed location as determined by short circuit study performed in accordance with Section 26 05 73.

D. Enclosures:

1. Comply with NEMA IA 10030.
2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1 or Type 12.

b. Outdoor Locations: Type 3R or Type 4.

3. Finish: Manufacturer's standard unless otherwise indicated.

2.11 ACCESSORIES

A. Pilot Devices:

1. Comply with NEMA IA 10039; heavy-duty type.
2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
4. Indicating Lights: Push-to-test type unless otherwise indicated.
5. Provide LED lamp source for indicating lights and illuminated devices.

B. Control and Timing Relays:

1. Comply with NEMA IA 10039.
2. Provide number and type of relays indicated or required to perform necessary functions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that service voltage and ratings of lighting control devices are appropriate for service voltage and load requirements at location to be installed.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes as required for installation of lighting control devices; see Section 26 05 33.16.

1. Mounting Heights: Unless otherwise indicated, as follows:

a. Wall Switch Occupancy Sensors: 48 inches (1.2 m) above finished floor.

2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches (80 mm) from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

C. Maintain separation of remote-control, signaling, and power-limited circuits.

1. See manufacturer instructions and Section 26 05 19 for control wiring conductors, wiring methods, and identification requirements.

D. Install lighting control devices in accordance with manufacturer's instructions.

E. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

F. Install lighting control devices plumb and level, and held securely in place.

G. Where required and not furnished with lighting control device, provide wall plate; see Section 26 27 26.

H. Provide required supports; see Section 26 05 29.

I. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

J. Identify lighting control devices; see Section 26 05 53.

K. Occupancy Sensor Locations:

1. Location Adjustments: Within design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage.
2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors minimum of 4 feet (1.2 m) from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

L. Outdoor Photo Control Locations:

1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by photo control itself.

M. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into photo control.

N. Daylighting Control Photo Sensor Locations:

1. Location Adjustments: Within design intent, reasonably minor adjustments to locations may be made in order to optimize control and avoid conflicts or problems affecting proper detection of light levels.
2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure light level controlled at designated task location, while minimizing measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into space, while minimizing measured amount of lighting from artificial sources.

O. Combination Enclosed Lighting Contactors:

1. Except where indicated to be mounted adjacent to equipment they supply, mount lighting contactors such that highest position of operating handle does not exceed 79 inches (2000 mm) above floor or working platform.

P. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

Q. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near sensor location.

R. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

S. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

T. Where indicated or required, provide cabinet or enclosure for mounting of lighting control device system components; see Section 26 05 33.16.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Test time switches to verify proper operation.

E. Test outdoor photo controls to verify proper operation, including time delays where applicable.

F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.

G. Correct wiring deficiencies and replace damaged or defective conductors, cables, and lighting control devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.

C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.

D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

E. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings in written report to be included with submittals.

F. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

G. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 COMMISSIONING

A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

3.8 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of installed lighting control devices.
4. Location: At project site.

END OF SECTION 26 09 23

SECTION 26 09 43.13 - DIGITAL-NETWORK LIGHTING CONTROLS

SECTION 260943.13 - DIGITAL-NETWORK LIGHTING CONTROLS

PART 1 GENERAL

2.1 SUMMARY

A. Section Includes:

1. System Software Interfaces.
2. System Backbone and Integration Equipment.
3. Wired Networked Devices.
4. Wireless Networked Devices.

B. Related Requirements:

1. Div. 26: Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262726 "Wiring Devices" for wired switches and dimmers and other Project requirements applicable to Work specified in this Section.

2.2 DEFINITIONS

A. Data Bus: A wired interface used to communicate with connected devices.

B. Device: A collective term for bus or wireless connected devices, including fluorescent ballasts, LED drivers, incandescent luminaires, manual switches, switching relays, sensors, and similar.

C. Global: Communication between devices in otherwise separate spaces using a bridging device or system controller.

D. Group: A set of devices that communicate together.

E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

F. Scene: Digital light level associated with a preset.

G. System Backbone: Devices used to connect and manage otherwise separate spaces, including bridging devices and gateways or system controllers. Used to expose devices to software configuration via TCP/IP.

2.3 REFERENCE STANDARDS

A. ANSI E1.11 - Entertainment Technology - USITT DMX512-A, Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories; 2024.

B. ANSI E1.20 - Entertainment Technology – Remote Device Management Over DMX512 Networks (RDM); 2025.

C. IEEE 802.15.4 - IEEE Standard for Low-Rate Wireless Networks; 2024.

D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

G. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

2.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site ???Insert location???.

B. Preinstallation Coordination Meeting(s): For digital-network lighting controls. Conduct meeting(s) as videoconference ???Insert location??? before ???Insert construction activity???.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect, Construction Manager of scheduled meeting dates.
2. Engage factory-authorized service representative to attend preinstallation conference and review the submittal drawing, sequence of operation, and device installation best practices with Project team.
3. Engage factory-authorized service representative to perform cellular signal strength measurements during site walk through and compare to Project plans to verify the placement of cellular antennas and quantity of lighting control system RF access points.

2.5 ACTION SUBMITTALS

A. Product Data:

1. Bill of Materials necessary to install the networked lighting control system.
2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
3. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
4. Other Diagrams and Operational Descriptions - as needed to indicate system operation or interaction with other system(s).

B. Shop Drawings:

1. Riser Diagrams showing device wiring connections of system backbone and typical per room/area type.

2.6 INFORMATIONAL SUBMITTALS

A. Contractor Startup/Commissioning Worksheet.

B. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

2.7 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Hardware and Software Operation Manuals
2. Maintenance service agreement.
3. Software service agreement.

B. Warranty documentation.

2.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Phone Support: Toll-free technical support available from manufacturer through an online tool to schedule a technical support appointment and provide 24/7 emergency support.
2. Remote Support: Manufacturer capable of providing remote support and ability to virtually connect with customers to address issues with visual guidance overlaid on images of real-world objects.
3. Cellular Connectivity: Manufacturer capable of cellular connectivity to a networked lighting control systems available to provide remote support within the continental United States.
4. On-Site Support: Manufacturer capable of providing a 72-hour, on-site response time within the continental United States.
5. Service Contracts: Manufacturer capable of providing service contracts for continued on-site and remote support of the lighting control system post-installation for terms up to 10 years from substantial completion, including:

a. Remote and on-site emergency response.

b. Remote system performance checks.

c. Remote diagnostics.

d. Replacement parts.

2.9 WARRANTY

A. Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:
    a. Faulty operation of lighting control hardware.
    b. Faulty operation of lighting control firmware.
2. Minimum Warranty Period: Five years from date of shipment.
3. Extended Warranty Period: ???Insert number??? year(s) from date of shipment.

PART 2 PRODUCTS

3.1 SYSTEM COMPLIANCE

A. System components manufactured in accordance with UL 916 and UL 924 standards where applicable.

B. System components manufactured in accordance with CFR Title 47, Part 15 standards where applicable.

C. System components manufactured in accordance with ISED Canada RSS-247 standards where applicable.

D. System components manufactured in accordance with IFT-008-2015 and NOM-208-SCFI-2016 standards where applicable.

E. System listed as qualified under DesignLights Consortium Networked Lighting Control System Specification v5.0.

F. Performance Criteria:
    1. Regulatory Requirements:
        a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3.2 SYSTEM PERFORMANCE REQUIREMENTS

A. System Architecture:
    1. System architecture based upon the following concepts:
        a. Networkable intelligent lighting control devices.
        b. Standalone lighting control zones using distributed intelligence.
        c. Optional system backbone for remote, time-based, and global operation.
    2. Intelligent lighting control devices with individually addressable network communication capability and having one or more basic lighting control components including: occupancy sensor, photosensor, relay, dimming output, contact closure input, analog 0-10 V(dc) input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure permissible to minimize overall system device count.

3. System capable of interfacing directly with networked luminaires such that either low-voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches, and system backbone.
4. Networked luminaires and intelligent lighting control devices support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.
5. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices capable of providing automatic control from sensors (occupancy and/or photosensor) and manual control from local wall stations without requiring connection to a higher-level system backbone.

    a. Lighting control zones (wired and wireless) support at least 128 devices per zone.

    b. Capable of being networked with a higher-level system backbone to provide time-based control, control from inputs or systems external to control zone, and remote configuration and monitoring through a software interface.

6. Networked luminaires and intelligent lighting control devices with distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones operate according to their defined default settings and sequence of operations.
7. System to include one or more system controllers that provide time-based control.
8. System controller provides means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP or BACnet MS/TP protocol.
9. System controller supports both low-voltage wired and wireless RF communication within a single controller device.
10. System devices support firmware update, either remotely or from within the application space, for purposes of upgrading functionality at a later date.
11. System capable of reporting lighting system events and performance data to management software for display and analysis.

B. Wired Networked Control Zone Characteristics:

1. Connections to devices within a wired networked lighting control zone and to backbone components accomplished with a single type of low-voltage network cable, compliant with CAT5e specifications or higher. Use of mixed types of low-voltage network cables is unacceptable.
2. Devices connected in "daisy-chain" topology. "Hub-and-spoke" topology, requiring all individual networked devices to be connected to a central component, is unacceptable, to reduce the total amount of network cable required for each control zone.
3. Pre-terminated, plenum-rated, low-voltage network cabling supplied with hardware.
4. Following proper installation and provision of power, all networked devices connected with low-voltage network cable must automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g. software application, handheld remote, pushbutton).

a. The "out of box" default sequence of operation is intended to provide typical sequence of operation to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.

5. System software capable of automatic discovery of all connected devices without requiring any provisioning of system or zone addresses.
6. Networked devices capable of detecting improper communication wiring and LED notification to alert installation/startup personnel.
7. Networked control devices suitable for control of egress or emergency light sources without additional, externally mounted UL 924 shunting or 0-10 V(dc) disconnect devices, to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. Capable of supporting the following sequence of operation:

    a. Low-Voltage Power Sensing: Devices automatically provide 100 percent light level upon detection of loss of power sensed via low-voltage network cable connection where applicable.

    b. Line-Voltage Power Sensing: Devices listed as UL 924 emergency relays which automatically close load-control relay and provide 100 percent light output upon detection of loss of power sensed via line voltage connection to normal power.

8. Global Control Zones: Networked luminaires and intelligent lighting control devices located in different areas able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span multiple areas. Occupancy, photosensor inhibit, and switch commands available across multiple controllers.
9. Wired Networked Wall Station Scene-Control Capabilities:

    a. Preset Scenes that activate a specific combination of light levels across multiple local and global channels.

    b. Local Profile Support: Profile Scenes that modify the sequence of operation for devices in the area (group) in response to a button press to dynamically optimize occupant experience and lighting energy usage.

        1) Wall stations able to manually start and stop local profiles, or local profile capable of ending after a specific duration of time between five minutes and 12 hours.

        2) Configurable Parameters:

            (a) Fixture light level.
            (b) Occupancy time delay.
            (c) Response to occupancy sensors (including enabling/disabling response).
            (d) Response to daylight sensors (including enabling/disabling response).
            (e) Enabling/disabling wall stations.

c. Three-Way or Multi-Way Control: Multiple wall stations capable of controlling the same local and global control zones, to support "multi-way" preset scene and profile scene control.

C. Wireless Networked Control Zone Characteristics:

1. No wired connections between networked devices required for the purposes of system communications.
2. Multiple wireless networking protocols supported:

   a. Standards-based, distributed star topology type of protocol for 900 MHz communication, to support lighting control applications and IoT applications.

   b. Bluetooth standard protocol for 2.4 GHz communication that supports direct connection to smartphone or tablet, to support device configuration, control applications, and IoT without requiring the use of a system backbone.

3. Wireless network must be self-healing, such that the loss of backbone or local communication between devices does not result in the loss of local control of lights in the space.
4. Wireless network communication must support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.
5. Communication of control signals from sensors and wall stations to networked luminaires and wireless load-control devices occur directly, without any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge, or gateway.
6. All wireless communication between lighting control components supports the following five tiers of security measures.

   a. Data encryption.

   b. Firmware protection.

   c. Tamper-proof hardware.

   d. Authenticated user access.

   e. Mutual device authentication.

7. Wireless devices use AES encryption to secure communication with a unique encryption key generated for each programmed site.
8. Wireless devices use signed firmware to ensure that unmodified, authentic software is always installed.
9. Wireless networked devices capable of communicating a minimum distance of 150 feet (4572 cm) between devices under typical site conditions accounting for typical environmental conditions and building construction materials encountered within commercial indoor lighting environments.
10. Minimum Line-of-Sight Communication Range: 1000 feet (30480 cm) under ideal environmental conditions.
11. Wireless devices self-identify when communication to system controller cannot be accomplished or when communication to the system controller is lost.

a. Self-identification not required for wireless switches or battery-powered devices.

12. Wireless devices self-establish connection to system controller through other devices if direct communication cannot be accomplished or when communication to system controller is lost.

    a. Communication path formation to utilize existing, wireless networked devices located between system controller and respective end devices.

    b. No additional hardware for formation of networked communication path between a system controller and end devices required.

    c. Automatic connection not required for wireless switches or battery-powered devices.

13. Networked control devices suitable for control of egress or emergency light sources without additional, externally mounted UL 924 shunting or 0-10 V(dc) disconnect devices, to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. Capable of supporting the following sequence of operation:

    a. Line-Voltage Power Sensing: Devices listed as UL 924 emergency relays that automatically close load-control relay and provide 100 percent light output upon detection of loss of power sensed via line voltage connection to normal power.

    b. Normal-Power-Broadcast Sensing: Devices listed as UL 924 emergency relays that automatically close load-control relay and provide 100 percent light output upon loss of a wireless normal-power broadcast from devices connected to normal power.

D. System Integration Capabilities:

1. Capable of interface with third-party building management systems (BMS) to support two-way communication using BACnet/IP protocol, BACnet MS/TP protocol, and RESTful API including the following system integration capabilities:

    a. "Write" messages for control of individual devices, including control of relay and dimming output.

    b. "Write" messages for control of groups of devices through a single command, including control of relay and dimming output of all devices.

    c. "Read" messages for individual device status information.

        1) Available status will vary based on device type and capabilities, which may include relay state, dimming output, power measurement, occupancy sensor status, and photosensor light measurement.

    d. "Read" messages for group status information for occupancy, relay state, and dimming output.

    e. Activation of pre-defined system Global Profiles.

2. Activation of Global Profiles from third-party systems via dry contact closure output signals or digital commands via RS-232 or RS-485.
3. Activation of demand response levels from Demand Response Automation Servers (DRAS) via OpenADR 2.0a protocol.

E. Supported Sequence of Operations:

1. Control Zones:

a. Local Control Zones: Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) capable of transmitting and tracking occupancy sensor, photosensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within area. These will also be referred to as local control zones.

b. Adjacent Control Zones: Networked luminaires and intelligent lighting control devices capable of tracking occupancy broadcasts from adjacent zones. When this feature is enabled, luminaire output for a vacant zone will reduce to a configurable dimmed state if one or more adjacent zones are occupied. Luminaires will turn off when both primary and adjacent zones are vacant.

c. Global Control Zones: Networked luminaires and intelligent lighting control devices located in different areas able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy, photosensor inhibit, and switch commands available across multiple controllers.

2. Wall Station Capabilities:

a. Wall stations support the following capabilities:

1) On/Off of a local or global control zone.

2) Continuous dimming control of light level of a local or global control zone.

b. Multi-Way Control: Multiple wall stations capable of controlling the same local or global control zones, to support "multi-way" switching and dimming control.

3. Occupancy Sensing Capabilities:

a. Occupancy sensors configurable to control a local or global zone.

b. Multiple occupancy sensors capable of controlling the same local or global zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.

c. Occupancy sensing sequence of operation modes:

1) On/Off Occupancy Sensing.

2) Partial-On Occupancy Sensing.

3) Partial-Off Occupancy Sensing.

4) Vacancy Sensing (Manual-On / Automatic-Off).

d. On/Off, Partial-On, and Partial-Off Occupancy Sensing Modes Sequence of Operation:

1) Occupancy automatically turn lights on to a designated level when occupancy is detected. Designated occupied light level support at least 100 dimming levels.

2) Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.

3) System capable of combining Partial-Off and Full-Off operation by dimming lights to a designated level when vacant and turning the lights off completely after an additional time delay.

4) Photosensor readings, if enabled in occupancy sensing control zone, automatically adjust light levels during occupied or unoccupied conditions as necessary.

5) Wall station activation changes the dimming level or turn lights off as selected by the occupant. Lights optionally remain in this manually specified light level until the zone becomes vacant. Upon vacancy, normal sequence of operation resumes.

e. Vacancy Sensing or Manual-On/Automatic-Off Mode Sequence of Operation:

1) Activation of a wall station is required turn lights on. System capable of programming the zone to turn on to either a designated light level or previous user-set light level. Initially occupying the space without using a wall station must not result in lights turning on.

2) Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.

3) System capable of dimming the lights when vacant and then turning the lights off completely after an additional time delay.

4) System capable of an "automatic grace period" immediately following detection of vacancy, during which time any detected occupancy results in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.

5) Photosensor readings, if enabled in the Occupancy Sensing control zone, capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary.

6) Wall station interaction changes the dimming level or turn lights off as selected by occupant. Lights remain at manually specified light level until zone becomes vacant; normal sequence of operation resumes upon vacancy.

f. Occupancy time delays before dimming or shutting off lights separately programmable for all control zones from 15 seconds to 2 hours.

4. Photosensor Sensing Capabilities (Automatic Daylight Sensing):

a. Photosensor devices configurable to control a local zone.

b. Photosensor-Based Control:

1) Continuous Dimming: Control zone automatically adjusts dimming output in response to photosenor readings, to maintain a minimum light level consisting of both electric light and daylight sources. Photosensor response configurable to adjust set point and dimming rates.

5. Schedule Capabilities:

a. System capable of time schedules for time-of-day to override devices including offsets from dusk and dawn.

b. System capable of providing a visible "blink warning" five minutes prior to the end of the schedule.

c. Wall stations may be programmed to provide timed extensions/overrides that turn the lights on for an additional time period.

1) Timed override/extension duration programmable for each individual device, zone of devices, or customized group of devices, from five minutes to 12 hours.

6. Global Profile Capabilities:

a. System capable of automatically modifying the sequence of operation for selected devices in response to any of the following:

1) Time-of-day schedule.

2) Contact closure input state.

3) Manually triggered wired wall station input.

4) RS-232/RS-485 command to wired input device.

5) BACnet input command.

b. Global Profile Capabilities:

1) Global Profiles stored within and executed from the system controller (via internal timeclock). Dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.

2) Global Profile time-of-day schedules capable of recurrence settings including daily, specific days of week, every "n" number of days, weekly, monthly, and yearly. Lighting control global profile schedules support definition of start date, end date, end after "n" recurrences, or never ending.

3) Daylight savings time adjustments capable of being performed automatically, if desired.

4) Global Profile holiday schedules follow recurrent settings for specific U.S. holiday dates regardless if they always occur on a specific date or are determined by day/week of the month.

5) Global Profiles capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times automatically derived from location information using an astronomical clock.

6) Software management interface capable of displaying a graphic calendar view of profile schedules for each control zone.

7) Global Profiles capable of manual activation directly from system controller, specially programmed wired input devices, scene-capable wired wall stations, and software management interface.

8) Global Profiles selectable to apply to a single device, zone of devices, or customized group of devices.

9) Global Profile Configurable Parameters:

(a) Fixture light level.
(b) Occupancy time delay.
(c) Response to occupancy sensors (including enabling/disabling response).
(d) Response to daylight sensors (including enabling/disabling response).
(e) Enabling/disabling of wall stations.

c. Local and Global Profiles backed up and stored on software's host server such that Profile backup can be applied to a replacement system controller or wired wall station.

7. System supports automated demand response capabilities with automatic reduction of light level to at least three levels of demand response, configurable for each output device.

3.3 SYSTEMS SOFTWARE INTERFACES

A. Management Interface:

1. Web-based management interface for remote system control, live status monitoring, and configuration of lighting control settings and schedules.
2. Compatible with industry-standard web browser clients.
3. Minimum of 100 unique password-protected user accounts.
4. Minimum of three user permission levels: read-only, read and change settings, and full administrative system access.
5. Capable of restricting access for user accounts to specific devices within the system.
6. All system devices capable of being given user-defined names.
7. Device identification information displayed in the Management interface including:

a. Model number.

b. Model description.

c. Serial number or network ID.

d. Manufacturing date code.

e. Custom label.

f. Parent network device.

8. Management interface capable of displaying live status of a networked luminaire or intelligent control device including:

a. Luminaire on/off status.

b. Dim level.

c. Power consumption.

d. Device temperature.

e. PIR occupancy sensor status.

f. Microphonic occupancy sensor status.

g. Remaining occupancy time delay.

h. Photosensor reading.

i. Active Profiles.

9. Management interface capable of displaying and modifying the current active settings of a networked luminaire or intelligent control device including:

a. Dimming trim levels.

b. Occupancy sensor and photosensor enable/disable.

c. Occupancy sensor time delay and light level settings.

d. Occupancy sensor response (normal or vacancy).

e. Photosensor setpoints and transition time delays.

10. Management interface capable of applying settings changes for a zone of devices or a group of selected devices using a single action that does not require the user to apply settings changes for each individual device.
11. Management interface capable of compiling a printable network inventory report.
12. Management interface capable of compiling a printable report detailing all system profiles.
13. All sensitive information stored encrypted.
14. System software updates available for automatic download and installation via the Internet.

B. System Energy Analysis and Reporting:

1. Intuitive graphical screens to facilitate simple viewing of system energy performance.
2. Energy Scorecard: Summarized display that indicates calculated energy savings in dollars or KWh.

3. Software calculates allocation of energy savings by control measures including occupancy sensors, photosensors, and manual switching.
4. Energy savings data calculated for the system as a whole.
5. Time-scaled graph showing all relay transitions.
6. Time-scaled graph showing zone occupancy time delays.
7. Time-scaled graph showing the total light level.
8. Software capable of storing information remotely onto an open-source, object-relational database, such as PostgreSQL.
9. Data stored in the database will be accessed utilizing an open standard, application programming interface, such as Open Database Connectivity (ODBC).

C. Visualization and Programming Interfaces:

1. System provides an optional web-based visualization interface that displays a graphical floorplan.
2. Graphical floorplan will offer the following types of system visualization:

a. Full Device Option: Master graphic of entire building, by floor, showing each control device installed with zones outlined including:

1) Controls embedded light fixtures.

2) Controls devices not embedded in light fixtures.

3) Daylight sensors.

4) Occupancy sensors.

5) Wall switches and dimmers.

6) Scene controllers.

7) Networked relays.

8) Wired bridges.

9) System Controllers.

10) Wired relay panels.

11) Group outlines.

b. Group-Only Option: Master graphic of the entire building, by floor, showing only control groups outlined.

c. Pan and zoom commands supported to allow smaller areas to be displayed on a larger scale simply by panning and zooming each floor's master graphic.

d. Selecting any control device displays the following as applicable:

1) Device catalog number.

2) Device name and custom label.

3) Device diagnostic information.

4) Link to further information on device including status or current configuration.

3. Programming capabilities through the application will include the following:
    a. Switch, occupancy sensor, and photosensor zone configuration.
    b. Manual-on or automatic-on modes.
    c. Turn-on and dim to dimming levels.
    d. Occupancy sensor time delays and PIR sensitivity.
    e. Dual technology occupancy sensors sensitivity.
    f. Photosensor calibration adjustment and auto-setpoint.
    g. Multiple photosensor zone offset.
    h. Trim level settings.
    i. Preset scene creation and copy for scene-capable devices.
    j. Application of custom device labels to the Bluetooth Low-Energy Programming Devices and individual connected lighting control devices.
    k. Fade rate settings.

D. Smartphone Programming Interface for Wired and Wireless Devices:
1. Interface provided for both Apple iOS and Android operating systems that allows configuration of lighting control settings.
2. Application supports configuration of wireless networked control devices.
    a. Application access granted with valid user name and password.
    b. Access to program information governed by permission system that allows users to share access with other users and restrict access to those who should not be able to reconfigure the equipment.
    c. Indication of signal strength where multiple Bluetooth Low-Energy Programming Devices are available for configuration.
3. Application supports configuration or wired networked control devices.
    a. Connected device access granted through user-defined passcode at initial install.
    b. Indication of signal strength where multiple Bluetooth Low-Energy Programming Devices are available for configuration.
4. Programming Capabilities:
    a. Switch, occupancy sensor, and photosensor group configuration.
    b. Manual-on or automatic-on modes.
    c. Turn-on and dim to dimming levels.
    d. Occupancy sensor time delays and PIR sensitivity.

e. Dual technology occupancy sensors sensitivity.

f. Photosensor calibration adjustment and auto-setpoint.

g. Multiple photosensor zone offset.

h. Trim level settings.

i. Preset scene creation.

j. Application of custom device labels for individual connected lighting control devices.

k. Fade rate settings.

3.4 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller: Multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nECY or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. System Controller Processor: 32-bit microprocessor operating at a minimum of 1 GHz.
3. System Controller Memory: Minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support operating system and databases.
4. System Controller Functions:

a. Time-based control of downstream wired and wireless network devices.

b. Linking into an Ethernet network.

c. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.

d. Connection to various software interfaces, including management interface, historical database and analytics interface, and visualization interface.

5. Integral web server to support system controller configuration and diagnostics with control and visualization of connected devices.

a. Web Server Control Interface:

1) Display associated devices within the context of a graphical floorplan.

2) Provide control of output-capable devices through virtual sliders, toggle buttons, preset level widgets, and transparent layers on floorplan.

3) Control Capabilities:

(a) Control of individual output devices, including control of relay state and analog dimming level where applicable.
(b) Control of local lighting control zones, including control of relay state and analog dimming level where applicable.
(c) Control of global lighting control zones, including control of relay state and analog dimming level where applicable.
(d) Control of Global Profiles.

b. Visualization Interface:

1) Customizable display with the ability to superimpose colored, transparent layers representing real-time property values, including occupancy status, dimming level status, light level status, and online or offline status where applicable.

2) Ad hoc display of trended information via an intuitive values-over-time graph.

3) Report Creation:

(a) Reports accept and graphically display trended status datasets for creator selected devices or zones of devices.
(b) Report information displayed over a user-defined interval and date range.
(c) Reports exportable to a standard CSV format.

6. Graphical touch screen to support configuration and diagnostics.
7. Minimum of three RJ-45 networked lighting control ports for connection to any of the following:

a. Graphical touch screen.

b. Wired communication bridges.

c. Direct connection to networked wired luminaires and intelligent lighting control devices (up to 128 total devices per port).

8. Device will automatically detect all network-connected devices.
9. Capable of managing and operating a minimum of 750 networked devices (wired or wireless) per system controller.
10. Multiple System Controllers capable of connection via LAN for scalability to a minimum of 20,000 networked devices.
11. Supports BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without additional protocol translation gateways.

a. BACnet MS/TP Connection Speed: 9600 to 115200 baud rate.

b. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.

12. Integral FIPS 140-2, Level 1 cryptographic module.

13. Supports RESTful API for control of BACnet objects, user management, date and time, and file management.
14. NEMA 1 enclosure with Class 1 and Class 2 separation.
    a. Power Supply Voltage: 120 to 277 V(ac).
15. Automatic algorithm to eliminate redundant, wireless networked paths to streamline communication between the system controller and end devices.
16. System Controller Security Provisions:
    a. Disallow the use of default passwords and require passwords to be updated prior to use.
    b. Support user role-based access, such as administrator, user, and viewer.
    c. Signed firmware to ensure that unmodified, authentic software is always installed.
    d. IP-based communication protected with strong encryption algorithms such as AES or TLS1.2+.
    e. Prevent rollback of firmware to firmware versions with known, critical vulnerabilities.
    f. Valid cybersecurity listing through a third party.
17. Cellular Remote Access: Cellular router and modem for remote access.
    a. Router supports remote access to at least five system controllers on its local area network or network subnet.
    b. Remote access capable of device setting updates, schedule updates, system performance optimization, and diagnostics.
    c. Remote access enabled through outbound communication from router to an outside source. Solutions that begin communication via inbound requests for network access are unacceptable.
    d. Router supports outbound communication to manufacturer-hosted portal using TLS1.2 or greater in-transit encryption over a cellular or Ethernet connection.
    e. Router with integral firewall to prevent unauthorized access to devices connected to its local area network port.
    f. Router includes cellular SIM capable of connection to AT&T, T-Mobile, Sprint, US Cellular, Alaska Wireless, Telefonica, Tellus, Bell, or Sasktel networks where carrier service is available.
    g. Outbound communication from the router limited to whitelisted endpoints. Devices that allow unrestricted communication are unacceptable.
    h. Outbound communication from router includes only lighting control system information.

3.5 WIRED NETWORKED DEVICES

A. Wired Networked Wall Switches, Dimmers, Scene Controllers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPODM or comparable product by one of the following:
    a. Cooper Industries, Inc.
    b. Leviton Manufacturing Co., Inc.
    c. ???Insert manufacturer's name???.
2. Mounting: Suitable for installation in single-gang switch box.
3. Communication and low-voltage power delivered via standard low-voltage network cabling with RJ-45 connectors.
4. All switches detect valid communication and blink a unique LED pattern to visually indicate a potential wiring issue.
5. Devices with mechanical push buttons provide tactile and LED user feedback.
6. Devices with mechanical push buttons manufactured with custom button labeling.
7. Wall switch and dimmer options:
    a. Number of control zones: 1.
    b. Control Types Supported:
        1) On/Off.
        2) On/Off/Dimming.
        3) On/Off/Dimming/Correlated Color Temperature Control for specific luminaire types.
    c. Color: Ivory.
8. Scene Controller Options:
    a. Number of Scenes: 1.
    b. Control Types Supported:
        1) On/Off.
        2) On/Off/Dimming.
        3) Preset Level Scene Type.
        4) On/Off/Dimming/Preset Level for Correlated Color Temperature.
        5) Reprogramming of other devices within daisy-chained zone to implement user-selected lighting scene including manual start/stop from the scene controller, or optionally programmed automatic stop after a user-selectable duration between five minutes and 12 hours.
        6) Selecting a lighting profile to be run by device's upstream controller to implement a selected lighting profile across multiple zones including manual

start/stop from the scene controller, or optionally programmed automatic stop after a user selectable duration between five minutes and 12 hours.

c. Color: Ivory.

B. Networked Graphic Wall Stations:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPOD TOUCH or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Mounting: Suitable for installation in single-gang switch box.
3. Integral 3.5-inch (88 mm) capacitive full-color touch screen.
4. Power via polarity insensitive Class 2 low-voltage 15 to 24V (dc) power supply.
5. Device enables mobile application control of control zones and scenes through Bluetooth.
6. Communication over standard low-voltage network cabling with RJ-45 connectors.
7. User-customizable screen saver utilizing uploaded image file in common file format including jpg, png, gif, bmp, or tif.
8. Capable of configuration of all switches, dimmers, control zones, and lighting preset scenes via password-protected setup screens.
9. Graphic Wall Station Options:

a. Number of Control Zones: Up to 16.

b. Number of Scenes: Up to 16.

c. Profile Scene Duration: User configurable from five minutes to 12 hours.

d. Color: White.

C. Digital Time Clock:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nDTC or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Controls a linear bus of lighting devices suppling all time functions without connection to a system controller.

a. Programming of the linear bus of lighting devices must not require additional hardware, including computers, specialized dongles, or other connection devices.

b. Programming of the linear bus exclusively done through the touch-screen interface.

3. Capable of up to 32 schedules. Each schedule consists of one set of On and Off times per day for each day of the week and for each of two holiday lists. Schedules assignable to any individual relay or group of relays.
4. Operates from non-volatile memory so that all system programming is retained indefinitely.
5. Mounted inside a relay panel to eliminate the necessity for additional enclosures for complete installation.
6. Capacitive 3.5-inch (88 mm), full-color touch screen.

D. Wired Networked Digital Key Switches:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPODA KEY MNTN or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Mounting: Suitable for installation in single-gang switch box.
3. Communication and low-voltage power delivered via standard low-voltage network cabling with RJ-45 connectors.
4. All switches detect valid communication and blink a unique LED pattern to visually indicate a potential wiring issue.
5. LED user feedback to provide indication of on/off status of the programmed lights or scene, as well as indication of device power.
6. Digital Key Switch Options:

a. Control Types Supported:

1) On/Off.

2) On/Off/Dimming.

3) Preset Level Scene Type.

4) On/Off/Dimming/Preset Level for Correlated Color Temperature.

5) User-programmed local lighting scene run within a daisy-chained group including manual start/stop from the switch, or optionally programmed automatic-stop after a user-selectable duration between five minutes and 12 hours.

6) User-programmed global lighting profile run by an upstream controller across multiple groups including manual start/stop from the switch, or optionally programmed automatic-stop after a user-selectable duration between five minutes and 12 hours.

b. Color: Ivory.

E. Wired Networked Auxiliary Input / Output (I/O) Devices:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nIO series or comparable product by one of the following:
    a. Cooper Industries, Inc.
    b. Leviton Manufacturing Co., Inc.
    c. ???Insert manufacturer's name???.
2. Plenum rated.
3. Mounting: inline wired.
4. Communication and low-voltage power delivered to each device via standard low-voltage network cabling with RJ-45 connectors.
5. Auxiliary Input/Output Devices Options:
    a. Contact closure or pull-high input.
        1) Input programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.
    b. 0-10V analog input.
        1) Input supports zero to 10 V dimming output control from a dimmer switch.
        2) Input programmable to function as a daylight sensor.
    c. RS-232/RS-485 digital input.
        1) Input supports activation of up to four local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
        2) Provides relay and dimming level status to external device (e.g. Touchscreen) when polled.
    d. 0-10V dimming control output, capable of sinking up to 20mA.
        1) Output programmable to support all standard sequence of operations supported by system.
    e. Digital control output via eldoLED LEDcode communication.
        1) Output programmable to support light intensity control, as well as optional correlated color temperature (CCT) control, of the connected luminaire.

F. Wired Networked DMX Interface Stations:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPWDMX or comparable product by one of the following:
    a. ETC.
    b. Lutron.

c. ???Insert manufacturer's name???.

2. Description: Multi-protocol, bidirectional DMX512 playback (snapshot) and lighting control gateway.

   a. Capable of control of networked luminaire or all normal power lighting load types.

   b. Capable of control of DMX lighting through:

      1) DMX input for snapshot capture of lighting presets.

      2) Live control of intensity, hue, and saturation of configured DMX Zones from connected stations.

   c. Integral LED indicators for power, network traffic, processor health, identify, DMX port configuration and status.

   d. Support recall of up to 16 (total):

      1) Prerecorded scenes/snapshots for playback.

      2) DMX zones.

   e. Capable of preset playback as activated by any connected control station.

   f. Capable of DMX pass-through for real-time output of incoming DMX levels.

   g. Support four universes of ANSI E1.31 sACN-Streaming ACN (sACN), including priorities, for snapshot capture and recall.

   h. Support ANSI E1.20 RDM with PC-based software.

   i. Act as an ANSI E1.33 RDMnet controller.

3. General Requirements:

   a. Operating Voltages:

      1) PoE Class 2 Device.

      2) 24 V(dc) (not used if using PoE), 7 W maximum power consumption.

   b. Operating Temperature: Minus 32 to plus 113 deg F (0 to 45 deg C).

   c. DIN-Rail Mounted on DIN 43880 (35/7.5) rail.

   d. NEMA Type 1 enclosure.

      1) Enclosure Size: 10 inches (260 mm) wide by 13 inches (330 mm) high by 4.5 inches (114 mm) deep.

4. Features:

   a. Lighting control ports supports:

      1) Communication through lighting control (RJ-45) ports that supply 40 mA of power to each device via standard Category 5e low-voltage network cabling.

2) Detection of valid communication and blinking of a unique LED pattern to visually indicate a potential wiring issue.

b. DMX Ports:

1) Comply with the requirements of ANSI E1.11 USITT DMX512-A standards.

2) Configurable as Input or Outputs.

3) Support ANSI E1.31 sACN.

4) Support Pathway Secure Streaming ACN (ssACN).

5) Comply with California Title 1.81.26.

6) Comply with ANSI E1.20 RDM.

7) Capable of withstanding fault voltages of up to 250 V(ac) without damage.

c. Dry contact closure input to connect with external control systems to control a lighting control zone or scene.

d. Ethernet Ports:

1) Support IEEE 802.3af Power-over-Ethernet in absence of 24 V(dc).

2) Support auto-negotiated 10/100MB connections speeds.

3) Support IEEE 802.1AB Link Layer Discovery Protocol.

e. Test Functions:

1) Operate without need of a configuration PC to check local wiring.

2) Test connectivity with DMX lights and networked luminaire or all normal power lighting load types.

f. Complies with the following:

1) RoHS 2011/65/EU + A1 2015/863.

2) FCC.

G. Wired Networked Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nCM or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Detect the presence of human activity within space and fully control the on/off function of lights.
3. Utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.

4. Dual technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).
5. Dual technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT), which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.
6. All sensing technologies are acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
7. Ceiling, fixture, recessed, and corner mounted sensors available, with multiple lens options available customized for specific applications.
8. Communication and low-voltage power delivered to each device via standard low-voltage network cabling with RJ-45 connectors.
9. All sensors detect valid communication and blink a unique LED pattern to visually indicate a potential wiring issue.
10. Sensor programming parameter available and configurable remotely from the software and locally via the device push button.
11. Ceiling mount occupancy sensors include one integrated dry contact switching relay, capable of switching 1 A at 24 V, resistive only.
12. Sensors available with one or two occupancy "poles," each of which provides a programmable time delay.
13. Photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.
14. Photosensor provide one on/off set-point and include a dead band to prevent the artificial light from cycling. Delay incorporated into the photosensor to prevent rapid response to passing clouds.
15. Photosensor and dimming sensor's set-point and dead band automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-Point Programming" procedure. Min and max dim settings as well as set-point may be manually entered or modified.
16. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
17. Dual zone option available for On/Off Photosensor, Automatic Dimming Control Photosensor, or Combination units. The secondary daylight zone capable of being controlled as an "offset" from the primary zone.

H. Wired Networked Wall Switch Sensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nWSX LV or comparable product by one of the following:

    a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Mounting: Suitable for installation in single-gang switch box.
3. Communication and low-voltage power delivered via standard low-voltage network cabling with RJ-45 connectors.
4. All switches detect valid communication and blink a unique LED pattern to visually indicate a potential wiring issue.
5. Devices with mechanical push buttons provide tactile and LED user feedback.
6. Wall Switch Sensor Options:

a. User Input Control Types: On/Off.

b. Occupancy Sensing Technology: PIR only.

c. Daylight Sensing Option: Inhibit Photosensor.

d. Color: Ivory.

I. Wired Networked Embedded Fixture Sensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nES or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Network system sensors with occupancy sensors and/or dimming photosensors that can be embedded into luminaire such that only the lens shows on luminaire face.
3. Occupancy sensor detection pattern suitable for 7.5 to 20-ft. (2.2 to 6-m) mounting heights.
4. Embedded Sensor Options:

a. Occupancy Sensing technology: PIR only.

b. Sensing Option: Occupancy only.

J. Wired Networked Power Packs:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPP16 series or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Plenum rated.

3. Communication will be delivered to each device via standard low-voltage network cabling with RJ-45 connectors.
4. Supply Voltage: 120 to 277 V(ac).
5. Relay Output: Class 1 relay rated for 16 A at 277 V(ac) and 1/2 HP at 120 V(ac).
6. Dimming Output: 0-10 VDC Dimming output.
7. Sink Current: 100 mA at 0-10 V(dc).
8. Mounting: Integral 1/2-inch (16-mm) chase nipple. Plastic clips into junction box are unacceptable.

K. Wired Networked Relay and Dimming Panel:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; ARP or comparable product by one of the following:
    a. Cooper Industries, Inc.
    b. Leviton Manufacturing Co., Inc.
    c. ???Insert manufacturer's name???.
2. Outputs: 4 Individual relays per panel, with an equal number of individual 0-10 V(dc) dimming outputs.
3. Field Configurable Relays (FCR):
    a. Field configurable to operate in single-, double-, or triple-pole relay groupings.
    b. Field configurable to operate as normally closed or normally open.
    c. Provides visual status of current state and manual override control of each relay.
    d. Minimum Relay Contact Ratings:
        1) 40 A at 120-480 V(ac) Ballast.
        2) 16 A at 120-277 V(ac) Electronic.
        3) 20 A at 120-277 V(ac) Tungsten.
        4) 20 A at 48V (dc) Resistive.
        5) 2 HP at 120 V(ac).
        6) 3 HP at 240-277 V(ac).
        7) 65kA SCCR at 480 V(ac).
4. Dimming Output Rating: Minimum of 100 mA sink current per dimming output.
5. Relay and dimming outputs individually programmable.
6. Listing: UL 924 for control of emergency lighting circuits.
7. Power Supply: Integrated 120-277 V(ac) supply.
8. Low-Voltage Sensor Input:
    a. Configurable to support any of the following input types:
        1) Indoor Photosensor.
        2) Outdoor Photosensor.

3) Occupancy Sensor.

4) Contact Closure.

b. Low-voltage sensor input provides 24 V(dc) power for sensor so additional auxiliary power supplies are not required.

c. Sensor input supports all standard sequence of operations.

9. Integrated Digital Time Clock for local schedule control.
10. Contact Closure Input: One for each group of eight output relays that acts as a panel override to activate the normally configured state of all associated relays (i.e., normally open or normally closed).
11. Panel supplies current limited low-voltage power to other networked devices connected via low-voltage network cable.
12. Enclosure:

a. Enclosure Rating: NEMA 1.

b. Mounting: Surface mounted.

c. Cover: Hinged cover with keyed lock.

L. Wired Networked Bluetooth Low-Energy Programming Device:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nIO BT or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Plenum rated, inline wired, and screw mountable.
3. Communication and low-voltage power delivered to device via standard low-voltage network cabling with RJ-45 connectors.
4. Bluetooth communication allows connection from smartphone application for programming device settings within the local daisy-chain zone.
5. Device provides visual indication of remote Bluetooth connection via LED integrated into device enclosure such that it is visible from all angles while the zone is being programmed.

M. Wired Networked Communication Bridge:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nBRG or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Suitable for surface mount to a standard 4 by 4-inch (100 by 100 mm) square junction box.
3. Communication Ports: Eight RJ-45 ports for connection to lighting control zones (up to 128 devices per port), additional network bridges, and System Controller.
4. Capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to System Controller.
5. Power Input: Class 2 low-voltage supplied locally via a directly wired power supply.
6. Wired Bridge capable of redistributing power from its local supply and connected lighting control zones with excess power to lighting control zones with insufficient local power. Architecture enables loss of power to a particular area to be less impactful on network lighting control system.

3.6 WIRELESS NETWORKED DEVICES

A. Wireless Networked Wall Switches, Dimmers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPOD series or comparable product by one of the following:

   a. Cooper Industries, Inc.

   b. Leviton Manufacturing Co., Inc.

   c. ???Insert manufacturer's name???.

2. Mounting: Suitable for installation in single-gang switch box.
3. Wireless Communication:

   1) Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

   2) Security: AES-128 bit.

4. Power Supply: 120 to 277 V(ac).
5. Mechanical push buttons provide tactile and LED user feedback during button press.
6. Mechanical push buttons available with custom button labeling.
7. Wall Switches and Dimmer Options:

   a. Number of Control Zones: 1.

   b. Control Types Supported: On/Off and On/Off/Dimming.

8. Scene Switch Options:

   a. Number of Scenes: 2.

   b. Control Types Supported: On/Off, On/Off/Dimming, and Preset Level Scene Type.

9. Color: Ivory.

B. Wireless Networked Embedded Fixture Control Devices:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rIO or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Wireless Communication:

a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

b. Security: AES-128 bit.

3. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
4. Suitable for installation within a luminaire such that the control device is not visible on the luminaire face.
5. Devices available with integrated and remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
6. Antenna Color: White.
7. Dimming Output: 0-10V.
8. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

C. Wireless Networked Indoor Load Controllers with Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rLSXR or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Wireless Communication:

a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

b. Security: AES-128 bit.

3. Detect the presence of human activity within space and fully control the on/off function of lights.
4. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
5. Dual technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).
6. Dual technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT), which detects both occupant motion and sounds

indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.

7. All sensing technologies are acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include Passive Infrared (PIR) and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
8. Sensor programming parameters available and configurable remotely.
9. Ceiling, fixture, and junction box mounted sensors available, with multiple lens options available customized for specific applications.
10. Integral daylight photosensor for programmable daylight harvesting.
11. Photosensor includes adjustable illumination set-point and dead band to prevent the artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.
12. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
13. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.
14. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads 225 mA or greater.

D. Wireless Networked Indoor Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rCMS or comparable product by one of the following:

    a. Cooper Industries, Inc.

    b. Leviton Manufacturing Co., Inc.

    c. ???Insert manufacturer's name???.

2. Wireless Communication:

    a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

    b. Security: AES-128 bit.

3. Detect the presence of human activity within space and fully control the on/off function of lights.
4. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
5. Dual technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).

6. Dual technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT), which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.
7. All sensing technologies acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
8. Sensor programming parameters available and configurable remotely.
9. Ceiling, fixture, and junction box mounted sensors available, with multiple lens options available customized for specific applications.
10. Dry Contact Output: One integrated dry contact switching relay, capable of switching 100 mA at 24 V, resistive only.
11. Integral daylight photosensor for programmable daylight harvesting.
12. Photosensor includes adjustable illumination set-point and dead band to prevent the artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.
13. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

E. Wireless Networked Outdoor Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rSDGR or comparable product by one of the following:

    a. Cooper Industries, Inc.

    b. Leviton Manufacturing Co., Inc.

    c. ???Insert manufacturer's name???.

2. Wireless Communication:

    a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

    b. Security: AES-128 bit.

3. Mounting: Nipple mount with IP66 rating.
4. Supply Voltage: 120 to 277 V(ac).
5. Detect the presence of human activity within space and fully control the on/off function of lights.
6. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
7. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.

8. Sensor programming parameters available and configurable remotely.
9. Available with multiple lens options available for various mounting heights.
10. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads 225 mA or greater.
11. Integral daylight photosensor for programmable daylight harvesting.
12. Photosensor includes adjustable illumination set-point and dead band to prevent the artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.
13. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
14. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

F. Wireless Networked Indoor Embedded Sensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rES7 or comparable product by one of the following:

    a. Cooper Industries, Inc.

    b. Leviton Manufacturing Co., Inc.

    c. ???Insert manufacturer's name???.

2. Wireless Communication:

    a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

    b. Security: AES-128 bit.

3. Sensors consisting of occupancy sensors and dimming photosensor suitable for installation within a luminaire such that only the lens is visible on luminaire face.
4. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
5. Devices available with integrated and remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
6. Antenna Color: White.
7. Dimming Output: 0-10 V.
8. Detect the presence of human activity within space and fully control the on/off function of lights.
9. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
10. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.
11. Sensor programming parameters available and configurable remotely.
12. Available with multiple lens options available for various mounting heights.
13. Integral daylight photosensor for programmable daylight harvesting.

14. Photosensor includes adjustable illumination set-point and dead band to prevent artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.
15. Dead band setting verified and modified by sensor automatically every time lights cycle to accommodate physical changes in space (i.e., furniture layouts, lamp depreciation, or lamp outages).
16. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

G. Wireless Networked Outdoor Embedded Sensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rMSOD or comparable product by one of the following:

    a. Cooper Industries, Inc.

    b. Leviton Manufacturing Co., Inc.

    c. ???Insert manufacturer's name???.

2. Wireless Communication:

    a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

    b. Security: AES-128 bit.

3. Sensors consisting of occupancy sensors and dimming photosensor suitable for installation within a luminaire such that only the lens is visible on luminaire face.
4. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
5. Color: White.
6. Ingress Protection: Minimum IP66.
7. Devices available with remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
8. Detect the presence of human activity within space and fully control the on/off function of lights.
9. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
10. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.
11. Sensor programming parameters available and configurable remotely.
12. Available with multiple lens options available for various mounting heights.
13. Integral daylight photosensor for programmable daylight harvesting.
14. Photosensor includes adjustable illumination set-point and dead band to prevent artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.

15. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
16. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

H. Wireless Networked Power Packs:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPP series or comparable product by one of the following:
    a. Cooper Industries, Inc.
    b. Leviton Manufacturing Co., Inc.
    c. ???Insert manufacturer's name???.
2. Wireless Communication:
    a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
    b. Security: AES-128 bit.
3. Plenum rated.
4. Supply Voltage: 120 to 277 V(ac).
5. Relay Output: Class 1 relay rated for 20 A and 1.5 HP at 120 to 277 V(ac) and 5 A and 0.5 HP at 480 V(ac).
6. Dimming Output: 0-10 V(dc).
7. Sink Current: 150 mA at 0-10 V(dc).
8. Antenna Type: Integrated.
9. Programming parameters available and configurable remotely.
10. Mounting: Integral 1/2-inch (16-mm) chase nipple. Plastic clips into junction box are unacceptable.
11. Power Packs Options:
    a. Power Pack capable of full 20-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 150 mA of sink current.
    b. Power Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
    c. Listing: UL 924 for control of emergency lighting circuits, field configurable for two distinct sequence of operation:
        1) Power sense of normal power feed, where unit powers and controls emergency circuit, and loss of the normal power sense circuit forces the power pack to shunt closed, go to full bright, and ignore all system commands until normal power is restored.

2) Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

d. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads 425 mA or greater.

e. Chicago Plenum External Antenna:

1) Mounting: 1/2-inch (16-mm).

2) Ingress Protection: IP67.

I. Wireless Networked Communication Adapter:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nECYD or comparable product by one of the following:

a. Cooper Industries, Inc.

b. Leviton Manufacturing Co., Inc.

c. ???Insert manufacturer's name???.

2. Wireless Communication:

a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

b. Security: AES-128 bit.

3. Capable of supporting a minimum of 750 networked wireless devices per adapter.
4. Interface: USB connection.
5. Ingress Protection: Minimum IP66.
6. Mounting: Integral 1/2-inch (16-mm) chase nipple. Minimum 16 feet (487.68 cm) USB cable and optional cable extenders for remote mounting.

PART 3 EXECUTION

4.1 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables." Minimum conduit size is 1/2 inch (12.7 mm).

1. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
2. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems," and Section 260533.16 "Boxes and Covers for Electrical Systems,"

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

4.2 IDENTIFICATION

A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Identify all controls with device address.

D. Label each device cable within 6 inch (152.4 mm) of connection to bus power supply or termination block.

4.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by Architect ???Insert names or titles of witnesses???.

C. Tests and Inspections: Engage a factory-authorized service representative to perform test inspections.

1. Test each zone using local and remote control hardware.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

D. Nonconforming Work:

1. Lighting controls will be considered defective if they do not pass tests and inspections.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Field Test Reports: Engage a factory-authorized service representative to prepare field test reports.

1. Prepare functionality and inspection reports, including a certified report that identifies controls included and describes test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
2. Include list of all points created from actual tests of all addressed control points for lamps, ballasts, manual controls, and sensors.

4.4 REMOTE ACCESS

A. Digital network lighting control system capable of remote access by manufacturer with the following features:

1. System diagnostics including detection of fault condition in hardware or connected devices.

2. Access to all connected devices for complete programming including scheduling of time-of-day events and device parameters necessary to meet required sequence of operations.
3. Browser-based interface to verify system functionality.
4. On-demand access to manufacturer technical support for remote troubleshooting, diagnostics, configuration, and programming.
5. Owner training on the digital network lighting control system available remotely.

B. Remote access system fully functional over commercial celluar connection or Internet-connected ethernet network.

C. All hardware associated with remote access including cellular modem and cellular antenna are to remain on-site regardless of warranty or cellular contract status.

4.5 SYSTEM STARTUP

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Activate luminaires and verify that all maximum output levels match output levels detailed in an Owner-approved sequence of operations.
3. Confirm correct communications wiring, initiate communications between control devices and controller/gateways, and program the lighting control system in accordance with approved configuration schedules, time-of-day schedules, and input override assignments.
4. Program network devices to meet required sequence of operations.
5. Program and verify all sequence of operations.
6. Create backup of system programming.
7. Assist in installation of system software on customer-provided workstation or server.
8. Verify bidirectional communication of manufacturer-provided cellular router with manufacturer-managed remote access portal.
9. ???Insert startup steps if any???.

B. Commissioning Walkthrough: Engage factory-authorized service representative to collaborate with third-party commissioning agent to demonstrate lighting control system functionality and verify the system meets the specified Project requirements.

4.6 CLOSEOUT ACTIVITIES

A. Enhanced Documentation: Engage lighting system manufacturer to provide comprehensive system documentation including detailed programming, sequence of operation data per Project specifications, and related code requirements.

B. Training: Engage lighting system manufacturer to provide comprehensive system overview, software overview, and documentation relating to system operation and maintenance.

4.7 PROTECTION

A. After installation, protect digital network lighting controls from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

4.8 MAINTENANCE

A. Engage a factory-authorized service representative to perform on-site system adjustments.

1. On-Site Occupancy Adjustments: When requested within ???Insert number??? months from date of Substantial Completion, provide on-site settings adjustments to suit actual occupied conditions. Provide up to two ???Insert number??? visits to Project during other-than-normal occupancy hours for this purpose.
2. Prepare and submit report after each visit that details activities performed.

B. Engage a factory-authorized service representative to perform remote system adjustments.

1. Remote Occupancy Adjustments: When requested within ???Insert number??? months from date of Substantial Completion and project registration with lighting control system manufacturer, provide remote settings adjustments to suit actual occupied conditions. Provide up to ???Insert number??? sessions to Project during other-than-normal occupancy hours for this purpose.

    a. System to include manufacturer-provided cellular communication hardware and connection to the system for a minimum of ???Insert number??? months after substantial completion to allow for factory representative assistance with settings adjustments and system sustainment.

    b. For the remaining duration of the maintenance term, or in the event cellular connectivity is not available, manufacturer assistance must be available through an Owner-provided, Internet-connected network.

2. Prepare and submit report after each session that details activities performed.

C. Maintenance Service Agreement:

1. Beginning at Substantial Completion, verify that maintenance service agreement includes 12 months' full maintenance by manufacturer's authorized service representative.
2. Include monthly preventive maintenance.
3. Preventative maintenance to include:

    a. System diagnostic reports.

    b. System performance checks.

    c. Device firmware updates.

    d. Programming adjustment as required for proper lighting system operation.

    e. Expedited factory direct warranty processing, replacement, and programming of defective components.

4. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

END OF SECTION 26 09 43.13

SECTION 26 21 00 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical service requirements.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Materials and installation requirements for cast-in-place concrete equipment pads.

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

D. Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Section 26 05 33.13 - Conduit for Electrical Systems.

F. Section 26 05 33.23 - Surface Raceways for Electrical Systems: Wireways.

G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

H. Section 26 23 00 - Low-Voltage Switchgear: Service entrance equipment.

1. Includes non-utility electrical metering.

I. Section 26 24 13 - Switchboards: Service entrance equipment.

1. Includes non-utility electrical metering.

J. Section 26 24 16 - Panelboards: Service entrance equipment.

K. Section 26 27 13 - Electricity Metering: Non-utility electrical metering.

L. Section 26 28 16.16 - Enclosed Switches: Service entrance equipment.

M. Section 26 32 13 - Engine Generators: Emergency/standby power systems for interconnection with normal utility electrical supply.

N. Section 26 36 00 - Transfer Switches: Service entrance equipment.

O. Section 26 43 00 - Surge Protective Devices: Service entrance surge protective devices.

P. Section 31 23 16 - Excavation.

Q. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

R. Section 31 23 23 - Fill: Bedding and backfilling.

S. Section 33 71 19 - Electrical Underground Ducts, Ductbanks, and Manholes.

1.3 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.4 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.

B. Coordination:

1. Verify the following with Utility Company representative:

a. Utility Company requirements, including division of responsibility.

b. Exact location and details of utility point of connection.

c. Utility easement requirements.

d. Utility Company charges associated with providing service.

2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.

D. Utility Company charges associated with providing permanent service to be paid by Owner.

E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

F. Scheduling:

1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.6 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.

1. Obtain Utility company approval of shop drawings prior to submittal.

D. Drawings prepared by Utility Company.

E. Project Record Documents: Record actual locations of equipment and installed service routing.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. IEEE C2 (National Electrical Safety Code).
2. NFPA 70 (National Electrical Code).
3. The requirements of the Utility Company.
4. The requirements of the local authorities having jurisdiction.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics:

1. Service Type: Underground.
2. Service Voltage: 480Y/277 V, 3 phase, 60 Hz.
3. Service Size: _____.

C. Utility Company: _____.

1. Point of Contact: _____.
2. Address: _____.
3. Phone: _____.
4. Email: _____.

D. Division of Responsibility:

1. Pad-Mounted Utility Transformers:

a. Transformer Vaults and Pads: Furnished and installed by Contractor per Utility Company requirements.

b. Transformers: Furnished and installed by Utility Company.

c. Transformer Grounding Provisions: Furnished and installed by Contractor per Utility Company requirements.

d. Transformer Protective Bollards: Furnished and installed by Contractor per Utility Company requirements.

e. Primary:

1) Trenching and Backfilling: Provided by Contractor.

2) Conduits: Furnished and installed by Contractor.

3) Conductors: Furnished and installed by Utility Company.

f. Secondary:

1) Trenching and Backfilling: Provided by Contractor.

2) Conduits: Furnished and installed by Contractor.

3) Conductors: Furnished and installed by Contractor (Service Point at transformer).

2. Terminations at Service Point: PROVIDED BY THE CONTRACTOR.

E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Verify and mark locations of existing underground utilities.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required trenching and backfilling in accordance with Section 31 23 16 and Section 31 23 23.

E. Construct cast-in-place concrete pads for utility equipment in accordance with Utility Company requirements and Section 03 30 00.

F. Provide required protective bollards in accordance with Utility Company requirements.

G. Provide required support and attachment components in accordance with Section 26 05 29.

H. Provide grounding and bonding for service entrance equipment in accordance with Section 26 05 26.

I. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 05 53.

3.4 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION 26 21 00

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General-purpose transformers.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 33.13 - Conduit for Electrical Systems: Flexible conduit connections.

E. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

G. Section 26 24 16 - Panelboards.

H. Section 26 27 13 - Electricity Metering: Instrument transformers for electrical metering.

1.3 REFERENCE STANDARDS

A. 10 CFR 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.

C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.

F. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

G. NEMA ST 20 - Dry Type Transformers for General Applications; 2021.

H. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.

C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.

D. Manufacturer's equipment seismic qualification certification.

E. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Maintenance Data: Include recommended maintenance procedures and intervals.

H. Project Record Documents: Record actual locations of transformers.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.

1. Greater than 10 kVA: 104 degrees F (40 degrees C) maximum.
2. Less than 10 kVA: 77 degrees F (25 degrees C) maximum.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric: www.se.com/#sle.

D. Siemens Industry, Inc: www.new.siemens.com/#sle.

E. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:

1. Altitude: Less than 3,300 feet (1,000 m).
2. Ambient Temperature:

a. Greater than 10 kVA: Not exceeding 104 degrees F (40 degrees C).

b. Less than 10 kVA: Not exceeding 77 degrees F (25 degrees C).

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Primary Voltage: 480 volts delta, 3 phase.

C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Insulation System and Allowable Average Winding Temperature Rise:

1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

E. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

F. Winding Taps:

1. Less than 3 kVA: None.
2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

H. Sound Levels: Standard sound levels complying with NEMA ST 20

I. Mounting Provisions:

1. Less than 15 kVA: Suitable for wall mounting.
2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor clean, dry locations: Type 2.

b. Outdoor locations: Type 3R.

2. Construction: Steel.

a. Less than 15 kVA: Totally enclosed, non-ventilated.

b. 15 kVA and Larger: Ventilated.

3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

K. Accessories:

1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA EN 10250, type 3R assembly.
3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 26 05 33.13, 2 feet (600 mm) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Install transformers plumb and level.

G. Transformer Support:

1. Provide required support and attachment in accordance with Section 26 05 29, where not furnished by transformer manufacturer.

2. Provide required vibration isolation and/or seismic controls in accordance with Section 26 05 48.
3. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
4. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.
5. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

K. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.

L. Identify transformers in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

1. 167 kVA single phase, 500 kVA three phase and smaller:

    a. Perform turns ratio tests at all tap positions.

2. Larger than 167 kVA single phase and 500 kVA three phase:

    a. Verify that control and alarm settings on temperature indicators are as specified.

    b. Perform excitation-current tests on each phase.

    c. Measure the resistance of each winding at each tap connection.

    d. Perform an applied voltage test on all high- and low-voltage windings-to-ground.

3.4 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 22 00

SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Lighting and appliance panelboards.

B. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 22 00 - Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.

G. Section 26 27 13 - Electricity Metering: For interface with equipment specified in this section.

H. Section 26 28 13 - Fuses: Fuses for fusible switches and spare fuse cabinets.

I. Section 26 43 00 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2025.

D. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).

E. NEMA PB 1 - Panelboards; 2011.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less; 2023.

G. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 67 - Panelboards; Current Edition, Including All Revisions.

L. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

N. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

O. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

P. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

Q. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Identify mounting conditions required for equipment seismic qualification.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Panelboard Keys: Two of each different key.
3. See Section 26 28 13 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
2. Panelboards Containing Fusible Switches: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric: www.se.com/#sle.

D. Siemens Industry, Inc: www.new.siemens.com/#sle.

E. Substitutions: See Section 01 60 00 - Product Requirements.

F. Source Limitations: Provide panelboards and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).
2. Ambient Temperature:

a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

C. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Boxes: Galvanized steel unless otherwise indicated.

a. Provide wiring gutters sized to accommodate the conductors to be installed.

b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.

c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.

3. Fronts:

a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list and label panelboards as a complete assembly including surge protective device.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

N. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

O. Load centers are not acceptable.

P. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.
2. Sub-feed lugs.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:

a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

1) 22,000 rms symmetrical amperes at 240 VAC or 208 VAC.

2) 42,000 rms symmetrical amperes at 480 VAC.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

3. Conductor Terminations:

a. Provide mechanical lugs unless otherwise indicated.

b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

b. Provide interchangeable trip units for circuit breaker frame sizes 400 amperes and larger.

5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

a. Provide the following field-adjustable trip response settings:

1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

2) Long time delay.

3) Short time pickup and delay.

4) Instantaneous pickup.

5) Ground fault pickup and delay where ground fault protection is indicated.

b. Provide communication capability where indicated: Compatible with system indicated.

6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:

a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

b. Ground Fault Equipment Protection High Frequency (HF) Circuit Breakers: Designed to trip at 30 mA for protection of equipment.

c. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.

d. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

8. Do not use tandem circuit breakers.
9. Do not use handle ties in lieu of multi-pole circuit breakers.
10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
11. Provide the following features and accessories where indicated or where required to complete installation:

a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.

2.4 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install panelboards plumb.

G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.

I. Mount floor-mounted power distribution panelboards on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 30 00.

J. Provide minimum of six spare 1 inch (27 mm) trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

K. Provide grounding and bonding in accordance with Section 26 05 26.

1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

L. Install all field-installed branch devices, components, and accessories.

M. Provide fuses complying with Section 26 28 13 for fusible switches as indicated.

N. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

O. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

P. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.

Q. Set field-adjustable ground fault protection pickup and time delay settings as directed.

R. Provide filler plates to cover unused spaces in panelboards.

S. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:

1. Emergency and night lighting circuits.
2. Fire detection and alarm circuits.
3. Communications equipment circuits.
4. Intrusion detection and access control system circuits.
5. Video surveillance system circuits.
6. Detention control system circuits..

T. Identify panelboards in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

E. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

F. Test GFCI circuit breakers to verify proper operation.

G. Test shunt trips to verify proper operation.

H. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 24 16

SECTION 26 27 13 - ELECTRICITY METERING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Equipment for Owner electricity metering:

1. Multi-circuit electricity meters.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 33.16 - Boxes for Electrical Systems: Cabinets and enclosures for metering system components.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Requirements for Utility Company electricity metering.

F. Section 26 24 13 - Switchboards: For interface with meters specified in this section.

G. Section 26 24 16 - Panelboards: For interface with meters specified in this section.

H. Section 26 28 13 - Fuses.

1.3 REFERENCE STANDARDS

A. ANSI C12.1 - Electric Meters - Code for Electricity Metering; 2026.

B. IEC 62053-21 - Electricity Metering Equipment - Particular Requirements - Part 21: Static Meters for AC Active Energy (Classes 0,5, 1 and 2); 2020.

C. IEC 62053-23 - Electricity Metering Equipment - Particular Requirements - Part 23: Static Meters for Reactive Energy (Classes 2 and 3); 2020.

D. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

F. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

G. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work to provide equipment suitable for interface with electricity metering systems to be provided.
2. Coordinate the work with other installers to provide communication lines required for electricity metering system interface.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Conduct meeting with facility representative and other related equipment manufacturers to discuss electricity metering system interface requirements.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for electricity metering systems and associated components and accessories. Include ratings, configurations, standard wiring diagrams, dimensions, service condition requirements, and installed features.

C. Shop Drawings: Include system interconnection schematic diagrams showing all factory and field connections. Include requirements for interface with other systems.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field Quality Control Test Reports.

F. Project Record Documents: Record actual installed locations of meters and final equipment settings.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Electricity Meters:

1. _____.

2.2 EQUIPMENT FOR OWNER ELECTRICITY METERING

A. Provide microprocessor-based digital electricity metering systems including all instrument transformers, wiring, and connections necessary for measurements specified.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide electricity metering systems and associated components compatible with the equipment and associated circuits to be metered.

D. Service Conditions: Provide electricity meters suitable for operation under the service conditions at the installed location.

E. Enclosures:

1. Where not furnished by manufacturer, provide required cabinets and enclosures in accordance with Section 26 05 33.16.
2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

3. Finish: Manufacturer's standard unless otherwise indicated.

F. Instrument Transformers:

1. Comply with IEEE C57.13, where applicable.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Compatible with connected meters; replace meters damaged by connection of incompatible current transformers. Provide shorting terminal blocks for connection of secondaries where applicable.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

G. Accessories:

1. Wiring: Provide manufacturer's recommended cables as indicated or as required for connections between system components.

2.3 MULTI-CIRCUIT ELECTRICITY METERS

A. Multi-Circuit Electricity Meter:

1. Metering Capacity: As indicated or as required for circuits to be metered.
2. Accuracy:
    a. Real/Active Power/Energy: Revenue grade; plus/minus 1.0 percent; complying with ANSI C12.1 and/or IEC 62053-21 Class 1.
    b. Reactive Power/Energy: Plus/minus 2.0 percent, complying with IEC 62053-23 Class 2.
    c. Voltage: Plus/minus _____ percent.
    d. Current: Plus/minus _____ percent.
3. Measured Parameters:
    a. Voltage (Volts AC); line-to-line and line-to-neutral; per phase.
    b. Current (Amps); per phase.
    c. Frequency (Hz).
    d. Real/active power (kW); per phase and total of all phases.
    e. Reactive power (kVAR); per phase and total of all phases.
4. Data logging.
    a. Storage Capacity: _____ days of readings at 15 minute intervals.
5. Inputs:
6. Communications: Compatible with connected systems. Provide all accessories necessary for proper interface.
    a. Ethernet Communications: Support for Modbus TCP protocol.

B. Products - Multi-Circuit Electricity Meters:

1. _____.
2. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of metering systems and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive meters.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Provide required support and attachment components in accordance with Section 26 05 29.

D. Provide grounding and bonding in accordance with Section 26 05 26.

E. Provide fuses complying with Section 26 28 13 as required.

F. Identify meters and associated wiring in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

D. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

E. Correct deficiencies and replace damaged or defective metering system components.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

A. Program system parameters according to requirements of Owner.

3.5 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

3.7 PROTECTION

A. Protect installed system components from subsequent construction operations.

END OF SECTION 26 27 13

SECTION 26 27 23 - INDOOR SERVICE POLES

PART 2 PRODUCTS

1.1 UTILITY COLUMN COMPONENTS

A. Main Body: Steel.

B. Cover Plates: Steel.

C. Convenience Receptacle Configuration: NEMA WD 6; Type 5-15. Furnish 4 per column.

D. Telephone Connector: Modular, 4-position 4-conductor jack. Furnish 2 per column.

E. Data Communications Connector: Modular, 8-position, 8-conductor jack. Furnish 1 per column.

F. Foot: Suitable for carpet.

G. Provide concealed top clamp to fasten pole to inverted "T" grid ceiling suspension member.

1.2 ACCESSORIES

A. Trim plates for closing ceiling opening.

B. Flexible cable assembly with connector for branch circuit connections.

1.3 FABRICATION

A. Wire utility column with 12 AWG copper conductor to outlet box attached to top of pole. Allow 6 inch leads for connection to branch circuit (Allow 150 mm leads for connection to branch circuit).

B. Provide full-sized opening at top of pole.

C. Finish: Gray.

END OF SECTION 26 27 23

SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Wall dimmers.

C. Fan speed controllers.

D. Receptacles.

E. Wall plates and covers.

F. Floor box service fittings.

G. Poke-through assemblies.

H. Power pedestals.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 33.16 - Boxes for Electrical Systems.

D. Section 26 05 33.23 - Surface Raceways for Electrical Systems: Surface raceway systems, including multioutlet assemblies.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 05 83 - Wiring Connections: Cords and plugs for equipment.

G. Section 26 09 23 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.

H. Section 26 27 23 - Indoor Service Poles.

I. Section 26 29 13 - Enclosed Controllers: Manual motor starters and horsepower rated motor-starting switches without overload protection.

J. Section 27 10 00 - Structured Cabling: Voice and data jacks.

1.3 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h (Validated 2022).

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2017g (Validated 2023).

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.

E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

F. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).

G. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

J. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

K. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

L. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

M. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.

N. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1. Wall Dimmers: Include derating information for ganged multiple devices.

C. Samples: One for each type and color of device and wall plate specified.

D. Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data:

1. Wall Dimmers: Include information on operation and setting of presets.
2. GFCI Receptacles: Include information on status indicators.

H. Project Record Documents: Record actual installed locations of wiring devices.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
3. Extra Keys for Locking Switches: Two of each type.
4. Extra Wall Plates: One of each style, size, and finish.
5. Extra Flush Floor Service Fittings: Two of each type.
6. Extra Poke-Through Core Hole Closure Plugs: Two for each core size.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Products: Listed, classified, and labeled as suitable for the purpose intended.

E. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as Nationally Recognized Testing Laboratories (NRTL), and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICES - GENERAL REQUIREMENTS

A. Provide wiring devices suitable for intended use with ratings adequate for load served.

B. Prewired Wiring Device and Outlet Box Assemblies: Factory-assembled products complying with requirements for wiring devices, boxes, and wiring methods may be used in lieu of field-assembled products.

1. Wiring: See Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Boxes: See Section 26 05 33.16 - Boxes for Electrical Systems.

C. Wiring Device Applications:

1. Receptacles Installed Outdoors or in Damp or Wet Locations: Use weather-resistant GFCI receptacles with weatherproof covers.
2. Provide GFCI protection for:

a. Receptacles installed within 6 feet (1.8 m) of sinks.

b. Receptacles installed in kitchens.

c. Receptacles serving electric drinking fountains.

3. Single Receptacles Installed on Individual Branch Circuits: Provide receptacle ampere rating equal to branch circuit rating.
4. Flush Floor Service Fittings in Tile Floors: Use tile rings.
5. Flush Floor Service Fittings in Carpeted Floors: Use carpet flanges.

D. Wiring Device Finishes:

1. Provide wiring device finishes as described below, unless otherwise indicated.
2. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.
3. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
4. Wiring Devices Installed in Wet or Damp Locations: White with weatherproof cover.
5. Wiring Devices Installed in Detention Locations: Gray with stainless steel wall plate.
6. Above-Floor Service Fittings: Gray wiring devices with satin aluminum housing.
7. Flush Floor Box Service Fittings: Gray wiring devices with aluminum cover and ring/flange.
8. Flush Poke-Through Service Fittings: Gray wiring devices with aluminum cover and aluminum flange.

2.2 WALL SWITCHES

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell.com/#sle.
2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.3 WALL DIMMERS

A. Manufacturers:

1. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.
2. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.

B. General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

C. Control: Slide control type with separate on/off switch.

D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:

E. Provide locator light, illuminated with load off.

2.4 RECEPTACLES

A. Manufacturers:

1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
2. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
4. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.
6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:

1. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.
2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
3. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
4. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

D. GFCI Receptacles:

1. General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

    a. Provide test and reset buttons of same color as device.

2. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.
3. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
4. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.

E. USB Charging Devices:

1. General Requirements: Listed as complying with UL 1310.

    a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.

2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

F. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.

2.5 WALL PLATES AND COVERS

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.
6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Size: Standard; _____.
3. Screws: Metal with slotted heads finished to match wall plate finish.

C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

E. Weatherproof Receptacle Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.6 FLOOR BOX SERVICE FITTINGS

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell.com/#sle.
2. Thomas & Betts Corporation: www.tnb.com/#sle.
3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Service fittings compatible with floor boxes provided under Section 26 05 33.16 with components, adapters, and trims required for complete installation.

C. Above-Floor Service Fittings:

1. Single Service Pedestal Convenience Receptacles:

a. Configuration: One standard convenience duplex receptacle.

2. Dual Service Pedestal Combination Outlets:

a. Configuration:

1) Power: One standard convenience duplex receptacle.

2) Communications: One 1 inch bushed opening.

3) Voice and Data Jacks: As specified in Section 27 10 00.

b. Provide barrier to separate line and low voltage compartments.

D. Flush Floor Service Fittings:

1. Single Service Flush Convenience Receptacles:
    a. Cover: Rectangular.
    b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
2. Dual Service Flush Combination Outlets:
    a. Cover: Rectangular.
    b. Configuration:
        1) Power: One standard convenience duplex receptacle(s) with duplex flap opening(s).
        2) Communications: _____.
3. Dual Service Flush Furniture Feed:
    a. Cover: Rectangular.
    b. Configuration:
        1) Power: One 2-1/8 inch by 3/4 inch combination threaded opening(s).
        2) Communications: One 2-1/8 inch by 1 inch combination threaded opening(s).
4. Accessories:
    a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
    b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.7 POKE-THROUGH ASSEMBLIES

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
2. Thomas & Betts Corporation: www.tnb.com/#sle.
3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

C. Above-Floor Service Fittings:
1. Dual Service Pedestal Combination Outlets:
    a. Configuration:
        1) Power: One standard convenience duplex receptacle.

2) Communications: One 1 inch bushed opening.

b. Provide barrier to separate line and low voltage compartments.

D. Flush Floor Service Fittings:

1. Dual Service Flush Combination Outlets:

a. Cover: Hinged door(s).

b. Configuration:

1) Power: One standard convenience duplex receptacle(s).

2) Communications: _____.

2. Accessories:

a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

2.8 POWER PEDESTALS

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com/#sle.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Listed pedestal enclosures with provisions for wiring devices.

C. Construction: Steel with corrosion-resistant finish.

D. Outdoor Power Pedestals: NEMA EN 10250, Type 3R.

E. Power Pedestal Configuration:

1. Pedestal Height: _____ inches (_____ mm).
2. Wiring Devices: One 20 A weather- and tamper-resistant GFCI duplex receptacle.
3. Wiring Device Access: Provide hinged cover; lockable.
4. Mounting Provisions: Designed for surface mounting (hardscaped areas or concrete base in landscaped areas).
5. Finish: _____.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

F. Verify that core drilled holes for poke-through assemblies are in proper locations.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:

a. Wall Switches: 48 inches (1200 mm) above finished floor.

b. Wall Dimmers: 48 inches (1200 mm) above finished floor.

c. Receptacles: 18 inches (450 mm) above finished floor or 6 inches (150 mm) above counter.

2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
3. Locate wall switches on strike side of door with edge of wall plate 3 inches (80 mm) from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Unless otherwise indicated, GFCI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFCI protection.

I. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

J. Install wiring devices plumb and level with mounting yoke held rigidly in place.

K. Install wall switches with OFF position down.

L. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

M. Do not share neutral conductor on branch circuits utilizing wall dimmers.

N. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

O. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

P. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

Q. Identify wiring devices in accordance with Section 26 05 53.

R. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 27 26

SECTION 26 28 11.13 - LOW-VOLTAGE POWER CIRCUIT BREAKERS - SCHNEIDER ELECTRIC SQUARE D MASTERPACT

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Section 26 01 60.13 - Maintenance Services for Electrical Distribution Equipment - Schneider Electric EcoCare.

1.2 ABBREVIATIONS AND ACRONYMS

A. LVPCB: Low-voltage power circuit breakers.

B. ERMS: Energy reduction maintenance setting.

C. HMI: Human machine interface.

1.3 DEFINITIONS

A. Operator Interface Terminal (OIT): Locally mounted HMI device that provides remote monitoring and functions of connected equipment.

1.4 REFERENCE STANDARDS

A. IEC 61000-4-30 - Electromagnetic Compatibility (EMC) - Part 4-30: Testing and Measurement Techniques - Power Quality Measurement Methods; 2025.

B. IEC 62443-3-3 - Industrial Communication Networks – Network and System Security – Part 3-3: System Security Requirements and Security Levels; 2013 (Corrigendum 2014).

C. IEC 62443-4-1 - Security for Industrial Automation and Control Systems – Part 4-1: Secure Product Development Lifecycle Requirements; 2018.

D. IEC 62443-4-2 - Security for Industrial Automation and Control Systems – Part 4-2: Technical Security Requirements for IACS Components; 2019 (Corrigendum 2022).

E. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

F. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015, with Amendment (2024).

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 1066 - Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures; Current Edition, Including All Revisions.

J. UL 5500 - Remote Software Updates; Current Edition Including All Revisions.

1.5 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.
2. Requirements of local authorities having jurisdiction.
3. Applicable local codes.

B. Manufacturer Qualifications:

1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
3. Service, repair, and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.
4. Certified in accordance with ISO 14001, with product environmental profiles (PEPs) for specified products.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.

B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.

C. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.

D. Inspect products and report concealed damage or violation of delivery, storage, and handling requirements to Engineer.

1.7 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.8 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Schneider Electric; Square D MasterPacT Low-Voltage Power Circuit Breakers; www.se.com/#sle.

B. Source Limitations: Furnish products produced by same manufacturer as other electrical distribution equipment for project and obtained from single supplier.

2.2 LOW-VOLTAGE POWER CIRCUIT BREAKERS

A. Basis of Design: Schneider Electric; Square D MasterPacT Low-Voltage Power Circuit Breakers; www.se.com/#sle.

B. Listed as complying with UL 1066.

C. Provide sealed low-voltage power circuit breaker (LVPCB), manually operated, with integrally mounted electronic trip units.

D. Provide fixed mounted circuit breakers.

E. Circuit Breaker Rating: 100 percent rated.

F. Interrupting Rating: Available up to 130 kAIR RMS at 635 V, 200 kAIR RMS at 508 V, and 200 kAIR RMS at 254 V without fuses.

G. Thirty-Cycle Withstand Ratings: Comply with application requirements.

H. Close-and-Latch Rating: Up to 150 kA peak current.

I. Maximum Closing Time:

1. Provide maximum 5-cycle closing time.
2. Ratings Less than 800 A: 50 milliseconds.
3. Ratings Between 800 A and 4,000 A: 70 milliseconds.
4. Ratings Greater than 4,000 A: 80 milliseconds.

J. Service Life:

1. Frame Size of 3,200 A or Less: Certified for 10,000 operations without maintenance.
2. Frame Size Greater than 3,200 A: Certified for 5,000 operations without maintenance.
3. Provide visual contact wear indicator.

K. Operation:

1. Provide two-step, fully-stored energy devices for quick-make, quick-break operation.

a. Capable of open-close-open cycle without recharging.

b. Automatically charge motor operator when breaker is closed.

c. Step One: Actuation of operating handle or operation cycle of circuit breaker motor charges closing springs.

d. Step Two: Operation of local close button closes circuit breaker contact, automatically charging opening springs.

2. Anti-Pumping Function: Remains in open position if opening/closing commands occur simultaneously; after fault tripping or intentional opening using manual or electrical controls, requires closing order to be discontinued and reactivated.
3. Provide OPEN and CLOSE buttons with lockable clear cover.
4. Provide breaker contact and close spring status indicators; indicate "charged-not OK to close" if closing springs are charged but circuit breaker is not ready to close.
5. Locking Provisions: For locking in connected, test, or disconnected position.

   a. Pad-Lock Provisions: One to three.

   b. Key-Lock Provisions: One to two.

6. Support auxiliary status contacts for open/close (ON/OFF), tripped, ready to close, ready to open, and spring mechanism is charged to provide local or remote indications of proper breaker system functionality.
7. Provide safety interlock to keep circuit breaker open if trip unit is not installed.
8. Shunt Trip and Shunt Close Coils: Continuous-duty rated; intermittent duty rated coils dependent on coil clearing contact may be used where spare coil is provided for each breaker.

L. Construction:

1. Case: Polyester thermoset material with high dielectric strength.
2. Current-Carrying Components: Isolated from accessory mounting area and double-insulated from operator with accessory cover in place.
3. Isolate each phase and ground.
4. Equipped with metal filters to reduce effects of interruption on surfaces surrounding circuit breaker.
5. Secondary Wiring: Front accessible with cage clamp connections.
6. Comply with Registration Evaluation and Authorization and Restriction of Chemicals (REACH) and Restriction of Hazardous Substances (RoHS).

M. Electronic Trip Units:

1. Digital Modules:

   a. Provide capability to upgrade trip unit functions by uploading digital modules without requiring replacement/modification of hardware.

   b. Electronically manage trip unit protection functions independently of measurement functions by dedicated application-specific integrated circuit (ASIC).

   c. Support uploading of digital modules to trip unit without removing power from circuit breaker.

2. Provide local and remote trip indication with cause of trip (e.g., overload, short circuit, or ground fault).
3. Visually indicate circuit breaker operating status (normal, warnings, alarms, energy reduction maintenance setting) via color-changing backlit display.
4. Provide capability to set breaker locally, via smart mobile device, or remotely through communications.
5. Provide sealable door to block use of local display for deterrence of unwanted protection setting changes.
6. Support extraction of trip cause data from trip unit and adjustment of protection settings without 24 VDC power supply or when main circuit breaker is OFF using portable power supply connected through USB port, including battery pack, smart mobile device (USB OTG), or laptop PC.
7. Provide true RMS sensing through 40th harmonic; indicate long-time pickup with LEDs.
8. Coils: Provide status, self-diagnostics (functionality and number of coil operations), and wiring diagnostics. Coils without these features to be provided with separate system to communicate status/alarms to remote monitoring system.
9. Where indicated on drawings, provide electronic trip units with the following field-adjustable protection settings:
    a. Long-Time (ANSI 49RMS/51):
        1) Pickup: Adjustable from 40 to 100 percent of nominal current rating in 1 A increments; where 1 A increments are not possible, provide complete set of rating plugs for each breaker.
        2) Delay: Adjustable from 0.5 to 24 seconds at 600 percent of long-time pickup in 0.5-second increments.
    b. Instantaneous (ANSI 50):
        1) Pickup: Adjustable from 150 percent to 1,500 percent of nominal current rating.
        2) Selectable Breaking Times:
            (a) Standard: For selective coordination.
            (b) Fast: For limiting let-thru energy; between 25 and 30 milliseconds.
10. Provide dual trip curve settings for each protection function (LSIG) with separate settings for utility, generator set, or grid sources; selectable by digital input through I/O module, Ethernet, or local display.
11. Energy Reduction Maintenance Setting (ERMS):
    a. Trip Unit: Provide separate trip curve for arc energy reduction maintenance setting selected via physical selector switch or smart mobile device; operate in fast instantaneous trip mode (25 to 30 milliseconds), when trip curve is active.
    b. Provide remote indicator light to indicate trip unit is in ERMS mode.
12. Measurement and Analysis Functions:

a. Provide trip unit embedded measurement for real-time metering. Where trip unit embedded measurement is not available, provide external meter.

b. Metering Accuracy:

1) Current and Voltage: 0.5 percent.

2) Power and Energy: 1 percent.

3) Specified accuracies are for total measurement system, including CT and meter.

4) Full scale over range of 10 to 120 percent of long-time pickup.

c. Energy Measurement:

1) Imported and exported energy on each phase of power system network.

2) Active, reactive, and apparent energy, per phase and total.

d. Harmonic Analysis and Waveform Capture: Individual harmonics of voltages and currents up to 40th harmonic, calculated every 200 milliseconds in accordance with IEC 61000-4-30.

e. Support display of measurements on breaker HMI display, smart mobile device via Bluetooth, connected remote operator interface terminal, or remote monitoring system via Modbus TCP/IP.

f. Event Management:

1) Provide event management to assist in compliance with NFPA 70B.

2) Provide notification of alarms and traceability, including event history of trips, protection setting changes, diagnostics, metering, configuration, and operation.

3) Record date and time entry was made and user ID associated with change.

4) Support alarm activation based on measurement or counters.

5) Support availability of events by communication via Bluetooth and Modbus TCP/IP or by software engineering tool.

g. Internal Monitored Functions:

1) Circuit Breaker: Coil electrical continuity checks, circuit breaker closing time, gear motor charging time, circuit breaker closing and opening counter, circuit breaker time stamp closing and opening history log.

2) Trip Unit: Internal sensor continuity (CTs), external sensor disconnection (ENCT, ground-fault sensor, I/O modules), internal failure discrimination (ASIC, sensor plugs, internal battery, trip solenoid), wireless communication failure (Bluetooth low energy, Ethernet).

13. Smart Mobile Device App:

a. Communicate trip cause information to smart mobile device without requiring power to trip unit.

b. Provide virtual assistance in reclosing breaker after trip event utilizing information extracted from breaker, including waveform capture on trip event.

c. Display circuit breaker event information, potential trip causes, list of additional investigations needed to determine if power can be restored, and recommendations for power restoration.

14. Auto-Test Function: Monitor and communicate trip unit state, battery state, contact state, circuit breaker remaining life estimate (algorithm based), opening/closing function, and spring charging function; indicate by health state LED, embedded HMI display, and smart mobile device app.
15. Support remote open/close operation via wired communication or smart mobile device that delivers instructions based on ready-to-close, coil, and spring charging status.
16. Communications:

a. Provide USB communication/test port to check electronic and trip mechanism operation without requiring manufacturer's special hardware tool.

b. Provide wireless communication interface for protection settings and health checks using near field communications (NFC) and Bluetooth low energy (BLE) protocols.

c. Provide communication interface with two Modbus TCP/IP 10/100 Mbps ports (dual-port, single network) for connection to Ethernet network for real-time access to data and settings.

d. Provide embedded web page interface accessed via standard PC and web browser without requiring additional hardware or software.

e. Comply with Device Profile for Web Services (DPWS) for auto-discovery on local area network (LAN).

f. Capable of reporting drawout circuit breaker cradle position, viewable in embedded web page and over data connection to external monitoring software.

g. Trip unit and communication accessories for all Ethernet network accessible LV circuit breakers shall comply with cyber security global standards such as ISA/IEC 62443-4-1, ISA/IEC 62443-4-2, US cyber security regulations SB327, HB2395, NFPA 70 (NEC) 240.6 (D), UL 5500, DODI 8510.01, US data privacy regulations, and shall be part of a certified ISA/IEC 62443-3-3 reference architecture.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install circuit breakers in accordance with manufacturer’s written instructions.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.

1. Include necessary material, equipment, labor, and technical supervision.
2. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.

3.3 MAINTENANCE

A. See Section 26 01 60.13 for additional information.

B. Provide to Owner, as alternate to base bid, separate contract for switchgear service plan for two years from date of Substantial Completion including, but not limited to, dedicated customer success management team, priority remote and on-site (within 100 miles (160 km) of service location) expert support, discounted service rates, continuous monitoring and alarming, online training.

END OF SECTION 26 28 11.13

SECTION 26 28 13 - FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fuses.

1.2 RELATED REQUIREMENTS

A. Section 26 05 73 - Power System Studies: Additional criteria for the selection of protective devices specified in this section.

B. Section 26 28 16.16 - Enclosed Switches: Fusible switches.

C. Section 26 29 13 - Enclosed Controllers: Fusible switches.

1.3 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.

E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.

    a. Fusible Enclosed Switches: See Section 26 28 16.16.

2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com/#sle.

B. Littelfuse, Inc: www.littelfuse.com/#sle.

C. Mersen: ep-us.mersen.com/#sle.

D. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 APPLICATIONS

A. General Purpose Branch Circuits: Class RK1, time-delay.

B. Individual Motor Branch Circuits: Class RK1, time-delay.

C. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.

D. Primary Protection for Control Transformers: Class CC, time-delay.

2.3 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

1. Class RK1, Time-Delay Fuses:
2. Class RK1, Fast-Acting, Non-Time-Delay Fuses:

H. Class CC Fuses: Comply with UL 248-4.

1. Class CC, Time-Delay Fuses:
2. Class CC, Fast-Acting, Non-Time-Delay Fuses:

I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 26 28 13

SECTION 26 28 16.13 - ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of circuit breaker upon request.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of enclosed circuit breakers and adjacent equipment with all required clearances indicated.
2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
3. Include documentation of listed series ratings upon request.
4. Identify mounting conditions required for equipment seismic qualification.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Project Record Documents: Record actual installed locations of enclosed circuit breakers.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C) during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric: www.se.com/#sle.

D. Siemens Industry, Inc: www.new.siemens.com/#sle.

E. Substitutions: See Section 01 60 00 - Product Requirements.

F. Source Limitations: Provide enclosed circuit breakers and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.2 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).
2. Ambient Temperature: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

D. Short Circuit Current Rating:

1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

2. Label equipment utilizing series ratings as required by NFPA 70.

E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Provide thermal magnetic circuit breakers unless otherwise indicated.

H. Provide electronic trip circuit breakers where indicated.

I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
3. Provide surface-mounted enclosures unless otherwise indicated.

L. Provide externally operable handle with means for locking in the OFF position.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:

1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

C. Conductor Terminations:

1. Provide mechanical lugs unless otherwise indicated.
2. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

2. Provide interchangeable trip units where indicated.

E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

1. Provide the following field-adjustable trip response settings:

a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

b. Long time delay.

c. Short time pickup and delay.

d. Instantaneous pickup.

e. Ground fault pickup and delay where ground fault protection is indicated.

F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

G. Provide the following circuit breaker types where indicated:

1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
3. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

H. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

I. Provide the following features and accessories where indicated or where required to complete installation:

1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
2. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
3. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install enclosed circuit breakers plumb.

F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.

K. Identify enclosed circuit breakers in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than _____ amperes. Tests listed as optional are not required.

D. Test GFCI circuit breakers to verify proper operation.

E. Test shunt trips to verify proper operation.

F. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 28 16.13

SECTION 26 28 16.16 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.

E. Section 26 28 13 - Fuses.

F. Section 26 36 00 - Transfer Switches: Automatic and non-automatic switches listed for use as transfer switch equipment.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).

D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Identify mounting conditions required for equipment seismic qualification.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Project Record Documents: Record actual locations of enclosed switches.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C) during and after installation of enclosed switches.

PART 2 PRODUCTS

2.1 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).
2. Ambient Temperature: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:

1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
2. Minimum Ratings:

a. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.

G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

H. Provide with switch blade contact position that is visible when the cover is open.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

L. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

N. Heavy Duty Switches:

1. Comply with NEMA BS 31047.
2. Conductor Terminations:

a. Provide mechanical lugs unless otherwise indicated.

b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

a. Provide means for locking handle in the ON position where indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Identify enclosed switches in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 28 16.16

SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:

1. Magnetic motor starters.
2. General purpose contactors.
3. Manual motor starters.
4. Motor-starting switches without overload protection.

B. Overcurrent protective devices for motor controllers, including overload relays.

C. Control accessories:

1. Auxiliary contacts.
2. Pilot devices.
3. Control and timing relays.
4. Control power transformers.
5. Control terminal blocks.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 28 13 - Fuses: Fuses for fusible switches.

G. Section 26 29 23 - Variable-Frequency Motor Controllers.

1.3 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

E. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.

F. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.

G. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).

H. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

L. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.

M. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Include documentation of listed series ratings upon request.
5. Include documentation demonstrating selective coordination upon request.
6. Identify mounting conditions required for equipment seismic qualification.

D. Manufacturer's equipment seismic qualification certification.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Field Quality Control Test Reports.

G. Project Record Documents: Record actual installed locations of controllers and final equipment settings.

1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.

H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Rockwell Automation, Inc: www.rockwellautomation.com/#sle.

D. Schneider Electric: www.se.com/#sle.

E. Siemens Industry, Inc: www.new.siemens.com/#sle.

F. Substitutions: See Section 01 60 00 - Product Requirements.

G. Source Limitations: Provide enclosed motor controllers and associated components produced by single manufacturer and obtained from single supplier.

1. Motor-starting switches without overload protection may be produced by same manufacturer as wiring devices used for project.

2.2 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:

1. Provide controllers and associated components suitable for operation under the following service conditions without derating:

a. Altitude:

1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet (1,000 m).

2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet (2,000 m).

b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).

2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:

1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
2. Label equipment utilizing series ratings as required by NFPA 70.

F. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures:

1. Comply with NEMA IA 10030.
2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

    a. Indoor Clean, Dry Locations: Type 1 or Type 12.

    b. Outdoor Locations: Type 3R or Type 4.

3. Finish: Manufacturer's standard unless otherwise indicated.

I. Instrument Transformers:

1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

J. Magnetic Motor Starters: Combination type unless otherwise indicated.

1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
2. Noncombination Magnetic Motor Starters: NEMA ICS 2, Class A noncombination motor controllers with magnetic contactor(s) and overload relay(s).
3. Configuration: Full-voltage non-reversing unless otherwise indicated.
4. Minimum Starter Size: NEMA Size 0.
5. Disconnects: Circuit breaker type.

    a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required.

    b. Disconnect Switches: Fusible type unless otherwise indicated.

    c. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.

    d. Provide auxiliary interlock for disconnection of external control power sources where applicable.

6. Overload Relays: Bimetallic thermal type unless otherwise indicated.

K. General Purpose Contactors: Combination type unless otherwise indicated.

1. Combination Contactors: NEMA ICS 2, Class A combination controllers with magnetic contactor(s) and externally operable disconnect, but without integral overload relay(s).
2. Configuration: Full-voltage non-reversing unless otherwise indicated.
3. Minimum Contactor Size: NEMA Size 0.
4. Disconnects: Circuit breaker type.
    a. Circuit Breakers: Thermal magnetic unless otherwise indicated or required.
    b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
    c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
5. Pilot Devices Required:
    a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
    b. Contactors for motor applications where overload protection is provided separately or where motor contains integral thermal protectors to be provided with pilot devices as specified for magnetic motor starters above.

L. Manual Motor Starters:

1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
2. Configuration: Non-reversing unless otherwise indicated.
3. Fractional-Horsepower Manual Motor Starters:
    a. Furnish with toggle operator.
    b. Overload Relays: Bimetallic or melting alloy thermal type.
    c. Provide means for locking operator in the OFF position.
    d. Furnish Red ON indicating light where not within sight of equipment.
4. Integral-Horsepower Manual Motor Starters:
    a. Furnish with toggle or pushbutton operator.
    b. Overload Relays: Bimetallic or melting alloy thermal type.
    c. Provide means for locking operator in the OFF position.
    d. Furnish Red ON indicating light where not within sight of equipment.
    e. Provide auxiliary contact where indicated; normally open (NO) or normally closed (NC) as indicated or as required.

M. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:

1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
3. Trip-free operation.
4. Visible trip indication.
5. Resettable.

a. Employ manual reset unless otherwise indicated.

b. Do not employ automatic reset with two-wire control.

6. Bimetallic Thermal Overload Relays:

a. Provide ambient temperature compensation.

b. Interchangeable current elements/heaters.

c. Adjustable trip; plus/minus 10 percent of nominal, minimum.

d. Designed for quicker trip response under phase loss condition.

e. Trip test function.

7. Melting Alloy Thermal Overload Relays:

a. Interchangeable current elements/heaters.

B. Fusible Disconnect Switches:

1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA BS 31047, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
2. Fuse Clips: As required to accept indicated fuses.

a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

C. Circuit Breakers:

1. Interrupting Capacity (not applicable to motor circuit protectors):

a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

2. Motor Circuit Protectors:

a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.

b. Provide field-adjustable magnetic instantaneous trip setting.

c. Provide the following features and accessories where indicated or where required to complete installation:

3. Molded Case Circuit Breakers:

a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

1) Provide thermal magnetic circuit breakers unless otherwise indicated.

2) Provide electronic trip circuit breakers where indicated.

b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

2) Provide interchangeable trip units where indicated.

c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

1) Provide the following field-adjustable trip response settings:

(a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
(b) Long time delay.
(c) Short time pickup and delay.
(d) Instantaneous pickup.
(e) Ground fault pickup and delay where ground fault protection is indicated.

d. Provide the following features and accessories where indicated or where required to complete installation:

1) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
3) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
4) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.4 CONTROL ACCESSORIES

A. Auxiliary Contacts:

1. Comply with NEMA IA 10039.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:

1. Comply with NEMA IA 10039; heavy-duty type.
2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
4. Indicating Lights: Push-to-test type unless otherwise indicated.
5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:

1. Comply with NEMA IA 10039.
2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:

1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus _____ VA spare capacity.
2. Include primary and secondary fuses.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install enclosed controllers plumb and level.

F. Provide grounding and bonding in accordance with Section 26 05 26.

G. Install all field-installed devices, components, and accessories.

H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.

1. Verify motor-running protection.

D. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

E. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than _____ amperes. Tests listed as optional are not required.

F. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 01 79 00 - Demonstration and Training, for additional requirements.

B. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of enclosed controllers and associated devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

3.7 PROTECTION

A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION 26 29 13

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:

1. Engine and engine accessory equipment.
2. Alternator (generator).
3. Generator set control system.
4. Generator set enclosure.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 23 11 13 - Facility Fuel-Oil Piping:

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

D. Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

G. Section 26 36 00 - Transfer Switches.

H. Section 26 36 33 - Connection Cabinets for Portable Generators and Load Banks.

1.3 REFERENCE STANDARDS

A. ASTM D975 - Standard Specification for Diesel Fuel; 2026b.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.

D. NEMA MG 00001 - Motors and Generators; 2024.

E. NFPA 30 - Flammable and Combustible Liquids Code; 2024, with Errata (2025).

F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2024, with Amendment.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. NFPA 99 - Health Care Facilities Code; 2024, with Errata.

I. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.

J. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

K. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.

a. Transfer Switches: See Section 26 36 00.

2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.

1. Include generator set sound level test data.
2. Include characteristic trip curves for overcurrent protective devices upon request.
3. Include alternator thermal damage curve upon request.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Manufacturer's factory emissions certification.

PART 2 PRODUCTS

2.1 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:

1. Application: Emergency/standby.
2. Configuration: Single packaged engine generator set operated independently (not in parallel).

D. Packaged Engine Generator Set:

1. Type: Diesel (compression ignition).
2. Power Rating: _____ kW, standby.
3. Voltage: As indicated on drawings.

E. Generator Set General Requirements:

1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
2. Factory-assembled, with components mounted on suitable base.
3. List and label engine generator assembly as complying with UL 2200.
4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

G. Starting and Load Acceptance Requirements:

1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
4. Maximum Load Step: Supports 100 percent of rated load in one step.

H. Exhaust Emissions Requirements:

1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

2.2 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):

1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
2. Fuel Storage: Sub-base fuel tank.

3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
5. Sub-Base Fuel Tank:

    a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.

    b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.

    c. Features:

        1) Direct reading fuel level gauge.

        2) Normal atmospheric vent.

        3) Emergency pressure relief vent.

        4) Fuel fill opening with lockable cap.

        5) Dedicated electrical conduit stub-up area.

C. Engine Starting System:

1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):

    a. Battery Type: Lead-acid.

    b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.

    c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.

3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.

D. Engine Speed Control System (Governor):

1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:

1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

F. Engine Cooling System:

1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.

G. Engine Air Intake and Exhaust System:

1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

2.3 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 00001; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:

1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 00001, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 00001, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

2.4 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:

1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
2. Generator Set Control Functions:

a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).

b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.

c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.

d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.

e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.

f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).

g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.

3. Generator Set Status Indications:

a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.

b. Current (Amps): For each phase.

c. Frequency (Hz).

d. Real power (W/kW).

e. Reactive power (VAR/kVAR).

f. Apparent power (VA/kVA).

g. Power factor.

h. Duty Level: Actual load as percentage of rated power.

i. Engine speed (RPM).

j. Battery voltage (Volts DC).

k. Engine oil pressure.

l. Engine coolant temperature.

m. Engine run time.

n. Generator powering load (position signal from transfer switch).

4. Generator Set Protection and Warning/Shutdown Indications:

a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:

1) Overcrank (shutdown).

2) Low coolant temperature (warning).

3) High coolant temperature (warning).

4) High coolant temperature (shutdown).

5) Low oil pressure (shutdown).

6) Overspeed (shutdown).

7) Low fuel level (warning).

8) Low coolant level (warning/shutdown).

9) Generator control not in automatic mode (warning).

10) High battery voltage (warning).

11) Low cranking voltage (warning).

12) Low battery voltage (warning).

13) Battery charger failure (warning).

b. In addition to NFPA 110 requirements, provide the following protections/indications:

1) High AC voltage (shutdown).

2) Low AC voltage (shutdown).

3) High frequency (shutdown).

4) Low frequency (shutdown).

5) Overcurrent (shutdown).

c. Provide contacts for local and remote common alarm.

d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:

a. Event log.

END OF SECTION 26 32 13

SECTION 26 32 13.13 - DIESEL-ENGINE-DRIVEN GENERATORS - REHLKO POWER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Packaged diesel-driven-engine generator system and associated components.

1.2 REFERENCE STANDARDS

A. 29 CFR 1910.23 - Ladders; Current Edition.

B. API Std 2000 - Venting Atmospheric and Low-Pressure Storage Tanks; 2014 (Reaffirmed 2020).

C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

D. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

E. ASTM D975 - Standard Specification for Diesel Fuel; 2026b.

F. FBC TAS 202 - Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components Using Uniform Static Air Pressure; Testing Application Standard; 1994.

G. FBC TAS 203 - Criteria for Testing Products Subject To Cyclic Wind Pressure Loading; Testing Application Standard; 1994.

H. ISO 8528-5 - Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets - Part 5: Generating Sets; 2025.

I. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

K. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.

L. NEMA MG 00001 - Motors and Generators; 2024.

M. NFPA 30 - Flammable and Combustible Liquids Code; 2024, with Errata (2025).

N. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2024, with Amendment.

O. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.

Q. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

R. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

S. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

T. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

U. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

V. UL 2085 - Protected Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

W. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

X. UL 6200 - Controllers for Use in Power Production; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compatibility of generator sets, including the following:

a. Transfer switches.

2. Coordinate work to avoid placing ductwork, piping, equipment, or other potential obstructions within spaces dedicated to engine generator system.
3. Coordinate arrangement of equipment with dimensions and clearance requirements of equipment.
4. Coordinate to provide electrical circuits suitable for power requirements of auxiliary equipment and accessories.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work; require attendance of affected installers.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Submit manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

1. Include alternator starting capabilities, engine fuel consumption rates, cooling, combustion air, and exhaust requirements.
2. Include generator set sound level test data.
3. Include characteristic trip curves for overcurrent protective devices upon request.
4. Include alternator thermal damage curve upon request.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations.

1. Indicate system interconnection schematic diagrams showing factory and field connections.
2. Identify mounting conditions required for equipment seismic qualification.

D. Certificates:

1. Manufacturer's equipment seismic qualification certification.
2. Manufacturer's factory emissions certification.

E. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.

1. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

G. Source quality control submittals.

H. Field quality control submittals.

I. Manufacturer reports.

J. Manufacturer's qualification statement.

K. Installer's qualification statement.

L. Provide NFPA 110-required documentation from manufacturer where requested by authorities having jurisdiction, including the following:

1. Certified prototype tests.
2. Torsional vibration compatibility certification.
3. NFPA 110 compliance certification.
4. Certified rated load test at rated power factor.

M. Maintenance contract.

N. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity providing contract maintenance and trouble call-back service.

O. Specimen warranty.

P. Executed warranty.

Q. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.5 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 37.
2. NFPA 70.
3. NFPA 110; meet requirements for Level 1 system.
4. UL 2200.

B. Manufacturer Qualifications:

1. ISO 9001-certified for design, development, production, and service of complete product line.
2. Manufacturer specializing in manufacturing products specified in this section, with minimum 3 years of documented experience.
3. Manufacturer produces custom paralleling switchgear and controls.
4. Maintain 24-hour parts and service organization regularly engaged in maintenance contract programs to perform preventive maintenance and service on like equipment.
5. Provide service agreement, including system operation under simulated conditions, required adjustment to generator set, transfer switch, and switchboard controls, and certification in Owner's maintenance log of repairs made and functional tests performed on systems.

C. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience with engine generator systems of similar size, type, and complexity.

D. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL), and acceptable to authorities having jurisdiction.

E. Documents at Project Site: Maintain at project site one copy of reference standard documents containing execution requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

C. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.7 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.8 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Generator set standard warranty covering years or quantity of hours indicated for basis of design products in PART 2, whichever occurs first; warrant against defective material and workmanship in accordance with manufacturer's published warranty from date of initial startup.

1. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Rehlko Power Systems; www.powersystems.rehlko.com/#sle.

B. Other Acceptable Manufacturers:

1. Caterpillar Inc.

C. Substitutions: See Section 01 60 00 - Product Requirements.

D. Source Limitations: Furnish engine generator sets and associated components and accessories produced by single manufacturer and obtained from single supplier.

1. Obtain enclosure from engine-driven generator manufacturer.
2. Obtain subbase tank from engine-driven generator manufacturer.
3. Designed and Provided by Engine-Driven Generator Manufacturer: Generator controllers, annunciators, battery chargers, and monitoring equipment.

2.2 PACKAGED DIESEL-ENGINE-DRIVEN GENERATOR SYSTEM

A. Provide new diesel-engine-driven generator system consisting of equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, and other components as required for complete operating system.

B. Provide products listed, classified, and labeled as suitable for intended purpose.

C. System Description:

1. Application: Emergency/standby.
2. Configuration: Multiple packaged engine generator sets operated in parallel.
3. Total System Power Rating: As indicated on drawings.

D. Packaged Engine Generator Set - Basis of Design: Rehlko Power Systems; REOZV series; 600REOZVB; engine TWD1643GE.

1. Nameplate Rating: 750 kVA/600 kW, 480 V, 3-phase, wye, 60 Hz.
2. Controller: APM402.
3. Subtransient Reactance: Maximum of 16 percent.
4. Subbase Tank Capacity: Minimum of 12 hours of continuous engine generator operation at 100 percent of rated load, but not larger than permissible by applicable codes.

5. Service Conditions:
    a. Altitude: Sea level to 4,921 feet (1500 m).
    b. Ambient Temperature: 5 to 122 degrees F (Minus 15 to 50 degrees C).
6. Sound Level Limits, Operating at 100 Percent of Rated Load:
    a. Outdoor Installations: 92 dBA at 23 feet (7 m) in free field.
7. Warranty Period:
    a. Standard: Standby rating for 1 year or 2,000 hours.
    b. Extended Limited: Stationary standby rating for 2 years or 2,000 hours.

E. Packaged Engine Generator Set - Basis of Design: Rehlko Power Systems; KD series; KD700; engine KD18L06.

1. Nameplate Rating: 875 kVA/700 kW, 480 V, 3-phase, wye, 60 Hz.
2. Controller: APM603.
3. Subtransient Reactance: Maximum of 16 percent.
4. Subbase Tank Capacity: Minimum of 12 hours of continuous engine generator operation at 100 percent of rated load, but not larger than permissible by applicable codes.
5. Service Conditions:
    a. Altitude: Sea level to 1,000 feet (300 m).
    b. Ambient Temperature: 5 to 77 degrees F (Minus 15 to 25 degrees C).
6. Sound Level Limits, Operating at 100 Percent of Rated Load:
    a. Outdoor Installations: 84 dBA at 23 feet (7 m) in free field.
7. Warranty Period:
    a. Standard: Standby rating for 3 years or unlimited hours, United States only.

F. Generator Set General Requirements:

1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
2. Factory-assembled, with components mounted on base.
3. List and label engine generator assembly as complying with UL 2200 or CSA.
4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three-phase voltages and 1.0 power factor for single-phase voltages.
5. Provide guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
6. Main Overcurrent Protective Device (OCPD):
    a. Type: Thermal magnetic circuit breaker with electronic trip with long time and short time delay and instantaneous pickup.
    b. Trip Rating: Select according to generator set rating.

c. Provide factory-installed, line-side connections with lugs for load-side connections.

G. Finishes: Paint and coating of automotive quality with multilayer epoxy undercoat primer and powder-coat finish.

1. Indoor and Outdoor Enclosures and Components - Multistage Finishing Process from Manufacturer, Including:

a. Precleaning: Enclosure components cleaned with two-stage alkaline cleaning process to remove grease, grit, and grime from parts, then subjected to zirconium-based conversion coating process to prepare metal for electrocoat (e-coat) adhesion.

b. Primer: Enclosure parts to receive 100 percent epoxy primer electrocoat (e-coat) with high-edge protection.

c. Finish Coating:

1) Powder-baked paint for superior finish, durability, and appearance.

d. Minimum Enclosure Corrosion Resistance: 1,000-hour salt spray test in accordance with ASTM B117.

e. Provide powder coat or liquid coat for fading and abrasion resistance.

2. Subbase Tank Finishes:

a. Polyurea-texturized rubber coating for corrosion protection and surface grip from manufacturer.

b. Coating for corrosion protection and surface grip from manufacturer.

H. Service Conditions: Provide engine generator system and associated components suitable for operation under service conditions at installed location, including altitude and temperature range as indicated for basis of design products.

I. Starting and Load Acceptance Requirements:

1. Cranking Method: Cycle cranking complying with NFPA 110 for 15-second crank period, followed by 15-second rest period, with cranking limiter time-out after three cycles, unless otherwise required.
2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition, and lock out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds NFPA 110, Type 10.
4. Maximum Load Step: Supports 100 percent of rated load in one step.

a. Maximum Voltage Deviation with Load Step: 20 percent.

b. Maximum Frequency Deviation with Load Step: _____.

5. Motor Starting Capability: Supports starting of motor load indicated with maximum voltage dip of 15 percent.

J. Exhaust Emissions Requirements:

1. Comply with EPA, state, and local regulations applicable for stationary standby engines at time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and engineer. Where such modifications are made, provide field emissions testing as required for certification.

K. Sound Level Requirements: Limits as indicated for basis of design products, without sound barriers while operating at full load.

L. Interface with building automation system; see Section _____.

2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Standby Load Factor: Minimum in accordance with manufacturer recommendations.

C. Engine Fuel System - Diesel, Compression Ignition:

1. Fuel Source: Diesel, ASTM D975, Grade No.2-D or approved cold weather.
2. Fuel Storage: Subbase fuel tank.
3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filters; water separator; check valve to secure prime; manual fuel priming pump; and relief-bypass valve.

a. Provide fuel cooler where recommended by manufacturer.

4. Engine Fuel Connections: Provide manufacturer-approved flexible fuel lines for coupling engine to fuel source.
5. Subbase-Mounted, Double-Wall, Fuel-Oil Tank:

a. Provide subbase-mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142. Comply with authorities having jurisdiction requirements for containment provisions.

b. Tank Capacity: Size as indicated for basis of design products.

c. Steel Channel Support System: Reinforced steel box channel for generator support.

1) Include full-height gussets at either end of channel and at generator mounting locations.

d. Fuel Level Gauge: Direct-reading, UL-listed, magnetic fuel level gauge with hermetically sealed, vacuum-tested dial.

e. Low-Fuel Alarm Contact: Float-type switch for remote or local annunciation of low-fuel-level condition.

f. Fill Tube: 2-inch (25 mm) NPT (National Pipe Thread) opening with lockable cap.

g. Leak monitoring within containment area.

h. Tamper-proof fill port cover.

i. Fill-pipe spill containment, minimum capacity 5 gal (19 L).

j. Emergency inner- and outer-tank, UL-listed relief vents sized in accordance with API Std 2000, with opening pressure of 0.5 psig (3.5 kPa) and full opening pressure of 2.5 psig (17 kPa).

k. Additional Features:

1) Normal atmospheric vent.

2) Emergency pressure relief vent.

3) Fuel fill opening with lockable cap.

4) Dedicated electrical conduit stub-up area.

6. Fuel Maintenance System:

a. Description: Packaged, automated fuel filtration system with pump, filters, and controls for removing particulates and water from stored diesel fuel in single or multiple tanks.

b. Filtration: Multistage consisting of inline strainer, particulate filter, secondary particulate filter, tertiary final filter, and water coalescer.

c. Controls: Microprocessor-based; field programmable; Modbus network communications interface; touch-screen or keypad operator interface; system shutoff with audible and visual alarms for plugged filters, full water-separator, low flow, pump overload, and oil leak.

D. Engine Starting System:

1. System Type: Electric, with DC solenoid-activated starting motors.
2. Batteries:

a. Provide lead-acid type.

b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst-case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.

c. Provide battery rack, cables, and connectors suitable for supplied batteries; size battery cables according to manufacturer's recommendations, including cable length.

3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
    a. Comply with the following:
        1) CE-certified.
        2) NFPA 110.
    b. Environmental Conditions: Battery charger to withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
        1) Ambient Temperature: Minus 40 to 185 degrees F (Minus 40 to 85 degrees C) with full charger output available up to 122 degrees F (50 degrees C).
        2) Relative Humidity: 0 to 95 percent.
        3) Altitude: Meets full performance requirements from sea level to 5,000 feet (1600 m). Chargers installed at higher altitudes automatically derate output power to prevent overheating of internal components but remain operable.
    c. Charger Operation: Provide dual-rate battery charger with automatic float and equalize charging modes; minimum rating of 10 A; suitable for maintaining supplied batteries at full charge without manual intervention.
        1) Capable of returning supplied batteries from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
        2) Listed as complying with UL 1236.
        3) Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
        4) Provide integral DC output ammeter and voltmeter with 5 percent accuracy.
        5) Provide alarm output contacts as required for alarm indications.
        6) AC Input: Charger operates from 45 to 65 Hz AC source with voltage ranging from 105 to 264 Vrms.
    d. LCD Digital Display: AC input voltmeter, DC output voltmeter, and ammeter; 1 percent accuracy.
    e. LED Lamp Indicators: Current limit, AC ON, and charger fail.
    f. Charger Fail Alarm Contact, Dry Type: Voltage-free form "C" output.
    g. Filtered output for battery type indicated.
    h. Charger Enclosure: UL 50 and UL 50E, Type 1, IP20, wall-mounted and rated for generator duty with charger enclosure vibration resistance.

E. Engine Speed Control System (Governor):

1. Single-Engine Generator Sets Not Operated in Parallel: Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

F. Engine Lubrication System:

1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filters, and dipstick for oil level indication.

a. Provide oil cooler where recommended by manufacturer.

2. Closed Crankcase Ventilation System: Prevents crankcase oil vapor from draining or escaping engine.
3. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

G. Engine Cooling System:

1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing cooling while operating at full load under typical ambient temperature.
2. Fan Guard: Provide guard to protect personnel from accidental contact with fan.
3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst-case ambient temperature.

H. Engine Air Intake and Exhaust System:

1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

2.4 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1,800 rpm, 60 Hz output revolving field, synchronous generator complying with NEMA MG 00001; connected to engine with flexible coupling; voltage output configuration as indicated for basis of design products, with reconnectable alternator leads.

B. Exciter:

1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.

3. Voltage Regulation with PMG Excitation: Plus/minus 0.5 percent for constant load from no load to full load.

C. Temperature Rise at Full Load: Comply with UL 2200.

D. Insulation System: NEMA MG 00001, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 00001, drip-proof.

F. Total Harmonic Distortion: Maximum of 10 percent.

G. Subtransient Reactance: As indicated for basis of design products.

H. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.5 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Comply with UL 6200, including testing to AC output short-circuit requirement.

C. Include energy reduction maintenance switch/mode in accordance with NFPA 70, Chapter 2.

D. Control Panel:

1. Description:

a. Digital engine generator controller with integrated graphical touch screen TFT (thin film transistor) display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with included battery backup.

1) APM603: 7 inches (175 mm).

b. Controller Face Ingress Protection: IP 65.

c. Operating Temperature: Minus 40 to 70 degrees F (Minus 40 to 21 degrees C).

d. Maximum Operating Humidity: 95 percent noncondensing.

e. Corrosion Resistant: Tested in accordance with ASTM B117, salt spray test.

2. Configuration:

a. Group operating and safety indications, protective devices, basic system controls, and engine gauges.

b. Panel Mounting Method: Unit-mounted unless otherwise indicated; vibration isolated.

c. Panel powered from engine generator battery.

3. Generator Set Control Functions:

a. Mode Selector:

1) Off/Reset: Prohibits generator from starting and resets shutdowns. In this mode, controller does not respond to remote START and STOP commands.

2) Manual: Allows user to locally start and stop generator operation. In this mode, controller does not respond to remote START and STOP commands.

3) Auto: Allows generator to start and stop based on remote commands. In this mode, generator does not respond to manual START and STOP commands.

b. Emergency Stop Switch: Latch-type remote STOP switch, red in color with mushroom-type head. Depressing STOP button immediately stops generator set and locks out automatic remote starting.

c. Voltage Adjustment: Adjustable through range of plus/minus 10 percent.

d. Audible Alarm: Horn sounds for specific warning and shutdown conditions.

e. Alarm Silence/Lamp Test Pushbutton: Silences audible alarm when depressed. Controller indicating lights are simultaneously illuminated while actuated.

f. Fault light - LED indicating abnormal conditions:

1) Yellow: Active warning condition or mode selector switch not in automatic.

2) Red: Active shutdown condition.

g. Real-time clock and calendar for time-stamping events.

h. Load Management:

1) Programmable outputs to command connect and disconnect of loads based on system state:

(a) Loads connected based on available capacity.
(b) Loads disconnected at system startup.
(c) Loads disconnected based on maximum kW setting or under-frequency setting.

2) Support up to 16 load steps.

i. Programmable Engine Control Features:

1) Engine start delay.

2) Engine cooldown delay.

3) Warm-up delay based on time or engine temperature.

4) Idle speed.

5) Cyclic cranking with adjustable ON time, OFF time, and number of cycles.

j. Event Logging:

1) Maintain record of minimum of 1,000 events with date and time locally for warning and shutdown faults.

2) Event log easily available for download onto USB storage device or PC.

3) Event Snapshot: Capture 15 seconds of critical data around time of fault or warning. Data viewable on controller and downloadable.

k. Data Logging: Capable of time-based recording of customized parameters.

1) Parameters selectable from monitored parameters.

2) Sample period configurable from one second to one day.

3) Collected data stored on USB storage device plugged into control panel.

l. Minimum of three user access levels.

m. Password protection to prevent unauthorized modification to system parameters.

n. Customizable Interface:

1) Overview Screen: Dedicated screen allowing user to display up to 16 parameters for immediate access.

2) Favorites: User-customizable menu set up for enhanced usability.

4. Generator Set Status Indications:

a. Voltage (VAC): Line-to-line, line-to-neutral for each phase.

b. Current (A): For each phase.

c. Frequency (Hz).

d. Real power (W/kW).

e. Reactive power (VAR/kVAR).

f. Apparent power (VA/kVA).

g. Power factor.

h. Duty Level: Actual load as percentage of rated power.

i. Engine speed (rpm).

j. Battery voltage (VDC).

k. Engine oil pressure.

l. Engine coolant temperature.

m. Engine runtime (kW hours).

n. Ambient temperature.

o. Power factor total and per phase with leading/lagging indication.

p. kW total and per phase, 0.5 percent accuracy.

q. kVAR total and per phase, 0.5 percent accuracy.

r. kVA total and per phase, 0.5 percent accuracy.

s. kW hours.

t. Generator duty level (actual kW loading divided by kW nameplate).

5. Generator Set Protection and Warning/Shutdown Indications - Viewable During Operation from Control Panel:

a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2 or NFPA 99 systems, including the following protections/indications:

1) Overcrank (shutdown).

2) Low coolant temperature (warning).

3) High coolant temperature (warning).

4) High coolant temperature (shutdown).

5) Low oil pressure (shutdown).

6) Overspeed (shutdown).

7) Low fuel level (warning).

8) Low coolant level (warning/shutdown).

9) Generator control not in automatic mode (warning).

10) High battery voltage (warning).

11) Low cranking voltage (warning).

12) Low battery voltage (warning).

13) Battery charger failure (warning).

b. In addition to NFPA 110 requirements, provide the following protections/indications:

1) High AC voltage (shutdown).

2) Low AC voltage (shutdown).

3) High frequency (shutdown).

4) Low frequency (shutdown).

5) Overcurrent (shutdown).

6) Engine control module (ECM) digital trouble codes (warnings).

7) Engine control module (ECM) digital trouble codes (shutdowns).

8) Loss of engine control module (ECM) communications (shutdown).
9) Engine control module (ECM) mismatch (shutdown).
10) Local manual stop (shutdown).
11) Alternator protection (shutdown).
12) Overcurrent (warning).
13) Under frequency (warning).
14) Over frequency (warning).
15) Over power (warning).
16) Over power (shutdown).
17) Undervoltage (warning).
18) Overvoltage (warning).
19) User-defined input (warning).
20) User-defined input (shutdown).
21) No oil pressure signal (shutdown).
22) No speed sensor signal (shutdown).
23) Fail-to-start (shutdown).

c. Provide contacts for local and remote common alarm.

d. Provide lamp test function that illuminates indicator lamps.

6. Other Control Panel Features:

a. Event log.

b. Service Data: Stored in controller and available for display.

1) Generator model number and serial number.
2) Engine control module (ECM) serial number.
3) Alternator part number.
4) Engine model number and serial number.
5) Controller serial number and firmware version.

c. Operational Records: Stored in controller beginning at system startup.

1) Total runtime hours.
2) Total loaded hours.
3) Total unloaded hours.
4) Total kW hours.

5) Controller hours.

6) Controller runtime hours.

7) Engine control module (ECM) runtime hours.

8) Number of starts.

9) Number of crank attempts.

10) Last crank duration.

11) Last start runtime duration.

12) Last start date and time.

13) Last stop date and time.

d. Maintenance Records: Stored in controller beginning at system startup, user resettable to zero.

1) Total runtime hours since last maintenance.

2) Total loaded hours since last maintenance.

3) Total unloaded hours since last maintenance.

4) Total kW hours since last maintenance.

e. Communications Capability: Utilitze BACnet communication protocol. Provide accessories necessary for interface.

f. Remote monitoring capability _____.

E. Remote Annunciator:

1. Remote Annunciator Mounting: Wall-mounted; provide flush-mounted annunciator for finished areas and surface-mounted annunciator for unfinished areas, unless otherwise indicated.
2. Generator Set Status Indications:

a. Generator powering load via position signal from transfer switch.

b. Communication functional.

3. Generator Set Warning/Shutdown Indications:

a. Comply with NFPA 110; configurable for NFPA 110, Level 1 or Level 2 or NFPA 99 systems, including the following indications:

1) Warning:

(a) Low coolant temperature.
(b) High coolant temperature.
(c) Low oil pressure.
(d) Low fuel level.
(e) Low coolant level.
(f) Generator control not in automatic mode.

(g) High battery voltage.
(h) Low cranking voltage.
(i) Low battery voltage.
(j) Battery charger failure.

2) Shutdown:

(a) Overcrank.
(b) High coolant temperature.
(c) Low oil pressure.
(d) Overspeed.
(e) Low coolant level.

b. Provide audible alarm with silence function.

c. Provide lamp test function that illuminates indicator lamps.

F. Remote Emergency Stop: Provide approved red, mushroom-style remote emergency STOP button where indicated or required by authorities having jurisdiction.

2.6 GENERATOR SET ENCLOSURE

A. Enclosure Type: Skintight to generator set, sound attenuating, weather protective.

B. Comply with the following:

1. 29 CFR 1910.23.
2. Snow Load Rating: 70 psf (33.5 kPa).

C. Enclosure Material: Provide steel or aluminum enclosure.

D. Hardware Material: Stainless steel.

E. Color: Manufacturer's standard.

F. Provide slip-resistant treads for foot traffic.

G. Access Doors: Lockable, with locks keyed alike.

H. Provide external emergency power OFF (EPO) button.

I. Catwalk: Full-length catwalk or platform, with stairs and railings for access to doors along both sides and level with bottom of enclosure, as required for maintenance. Include slip-resistant treads.

J. Openings: Designed to prevent bird/rodent entry.

K. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

L. Sound-Attenuating Enclosures: Line enclosure with self-extinguishing, sound-attenuating material.

M. Electrical, Prewired from Factory: Provide load center and branch circuits. Include 10 percent spare branch breakers and minimum two general-purpose receptacles, GFCI-protected with in-use cover.

1. AC Lighting: Provide LED luminaires, weather-resistant, as indicated on drawings.

N. Provide motorized or gravity-activated automatic dampers for enclosure airflow.

O. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as required for operation at rated load under worst-case ambient temperature; insulation flammability classification complying with UL 94.

2.7 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

1. Generator set production testing to include, minimum:

a. Operation at rated load and rated power factor.

b. Single-step load pickup.

c. Transient and steady state voltage and frequency performance.

d. Operation of safety shutdowns.

e. Locked rotor amperage.

f. Overcrank.

g. Load Test: 25, 50, 75, and 100 percent of rated load.

2. Perform pressurized leak test on fuel storage tanks prior to shipment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements.

B. Verify ratings and configurations of generator sets and auxiliary equipment are consistent with indicated requirements.

C. Verify rough-ins for field connections.

D. Verify mounting surfaces are ready to receive equipment.

E. Verify conditions for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1.

B. Install products in accordance with manufacturer's instructions.

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on concrete pad, minimum 6 inches (150 mm) high.

F. Provide support and attachment.

G. Use manufacturer's recommended oil and coolant, suitable for worst-case ambient temperatures.

H. Provide diesel fuel piping and venting where not factory-installed.

I. Install diesel fuel maintenance system in accordance with manufacturer's instructions.

1. Position fuel intake and fuel return within tanks to maximize fuel circulation.
2. Do not exceed lift capabilities of circulating pump.
3. Provide isolation valves, foot valves, priming tees, relief valves, and check valves where called for by manufacturer.

J. Provide engine exhaust piping where not factory-installed.

1. Include required piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, and hangers/supports.
2. Do not exceed manufacturer's maximum back pressure requirements.

K. Do not insulate piping for engine components restricted by manufacturer.

L. Install exhaust silencer where not factory-installed.

M. Provide grounding and bonding in accordance with NFPA 70.

N. Identify system wiring and components.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Provide services of manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with requirements for scheduling inspections and tests and for observations.

E. Provide equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

F. Preliminary inspection and testing to include, minimum:

1. Inspect each system component for damage and defects.
2. Verify tightness of mechanical and electrical connections meets manufacturer's recommended torque settings.
3. Check oil and coolant levels.

G. Prepare and start system in accordance with manufacturer's instructions.

H. Perform acceptance test in accordance with NFPA 110.

I. Inspection and testing to include, minimum:

1. Verify compliance with starting and load acceptance requirements.
2. Verify voltage and frequency; make required adjustments.
3. Verify phase sequence.
4. Verify control system operation, including safety shutdowns.
5. Verify operation of auxiliary equipment and accessories (e.g., battery charger and heaters).
6. Perform load tests in accordance with NFPA 110 1.5-hour building load test followed by 2-hour full load test.

J. Provide field emissions testing where necessary for certification.

K. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.

L. Correct defective work, adjust for operation, and retest until system complies with Contract Documents.

M. In detailed reports, indicate inspection and testing results and corrective actions taken.

3.4 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material, and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals for additional submittals.

B. See Section 01 79 00 - Demonstration and Training for additional requirements.

C. Demonstrate operation of system to Owner's designated representative; correct identified deficiencies and make required adjustments.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of 4 hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

E. After successful acceptance test and just prior to Date of Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.6 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

3.7 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Provide to Owner proposal, as alternate to base bid, for separate maintenance contract for service and maintenance of engine generator system for 2 years from Date of Substantial Completion.

1. Include complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with detailed schedule.

C. Conduct site visit at least once every 3 months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed, along with evaluations and recommendations.

D. Provide trouble callback service upon notification by Owner:

1. Provide on-site response within 4 hours of notification.
2. Include allowance for callback service during normal working hours at no extra cost to Owner.
3. Owner pays for callback service outside of normal working hours on hourly basis, based on actual time spent at site and excluding travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Maintain on-site log listing date and time of each inspection and callback visit, condition of system, nature of trouble, correction performed, and parts replaced.

END OF SECTION 26 32 13.13

SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 14 21 00 - Electric Traction Elevators: For interface with transfer switch.

C. Section 14 24 00 - Hydraulic Elevators: For interface with transfer switch.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

E. Section 26 05 29 - Hangers and Supports for Electrical Systems.

F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

G. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment specified in this section.

H. Section 26 21 00 - Low-Voltage Electrical Service Entrance.

1. Includes Utility Company contact information.

I. Section 26 28 16.16 - Enclosed Switches: Safety switches not listed for use as transfer switch equipment.

J. Section 26 32 13 - Engine Generators: For interface with transfer switches.

1. Includes code requirements applicable to work of this section.
2. Includes additional testing requirements.
3. Includes related demonstration and training requirements.

K. Section 26 36 33 - Connection Cabinets for Portable Generators and Load Banks.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NEMA IA 10042-1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2025.

D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.

G. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.

a. Engine Generators: See Section 26 32 13.

2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

1. Where applicable, include characteristic trip curves for overcurrent protective devices upon request.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

1. Clearly indicate whether proposed short circuit current ratings are based on testing with specific overcurrent protective devices or time durations; indicate short-time ratings where applicable.
2. Identify mounting conditions required for equipment seismic qualification.

D. Manufacturer's equipment seismic qualification certification.

E. Specimen Warranty: Submit sample of manufacturer's warranty.

F. Evidence of qualifications for installer.

G. Evidence of qualifications for maintenance contractor (if different entity from installer).

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

I. Manufacturer's certification that products meet or exceed specified requirements.

J. Source quality control test reports.

K. Manufacturer’s detailed field testing procedures.

L. Field quality control test reports.

M. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

N. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

O. Maintenance contracts.

P. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

Q. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70 (National Electrical Code).

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1. Authorized service facilities located within 200 miles (320 km) of project site.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with power transfer systems of similar size, type, and complexity; manufacturer's authorized installer.

E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

1. Contract maintenance office located within 200 miles (320 km) of project site.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Transfer Switches:

1. ABB: www.electrification.us.abb.com/#sle.
2. Eaton Corporation: www.eaton.com/#sle.
3. Rehlko: www.powersystems.rehlko.com/#sle.
4. Schneider Electric; ASCO Power Technologies: www.ascopower.com/#sle.
5. Thomson Power Systems: www.thomsonps.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.
7. Source Limitations: Provide transfer switches and accessories produced by single manufacturer and obtained from single supplier.

2.2 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:

1. Utilize open transition transfer unless otherwise indicated or required.

2. For transfer of highly inductive loads (e.g. large motors and transformers), utilize open transition transfer with in-phase monitor or delayed transition transfer.
3. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):
    a. Unless otherwise indicated or required, provide solid (unswitched) neutral.
    b. Unless otherwise indicated or required, provide neutral switching:
        1) For systems with ground fault protection.
        2) Where the alternate/emergency source is a separately derived system.
4. Provide signal before transfer contacts for transfer switches serving elevators.

D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Automatic Transfer Switch:

1. Transfer Switch Type: Automatic transfer switch.
2. Transition Configuration: Open-transition (no neutral position).
3. Voltage: As indicated on the drawings.
4. Ampere Rating: As indicated on the drawings.
5. Neutral Configuration: Switched neutral.
6. Load Served: As indicated on the drawings.
7. Primary Source: As indicated on the drawings.
8. Alternate Source: As indicated on the drawings.
9. Products:
    a. Schneider Electric; ASCO 300 Series Automatic Transfer Switches: www.ascopower.com/#sle.
    b. Substitutions: See Section 01 60 00 - Product Requirements.

F. Comply with NEMA IA 10042-1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

G. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

H. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

I. Switching Methods:

1. Open Transition:
    a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.

b. Where in-phase transfer is indicated, utilize in-phase monitor to initiate transfer when phase angle difference between sources is near zero to limit in-rush currents.

2. Delayed Transition:

a. Provide break-before-make transfer with programmable time delay in a neutral position not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.

3. Neutral Switching: Either simultaneously switched neutral (break-before-make) or overlapping neutral (make-before-break) methods are acceptable.
4. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

J. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

K. Enclosures:

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1 or Type 12.

2. Finish: Manufacturer's standard unless otherwise indicated.

L. Short Circuit Current Rating:

1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

M. Automatic Transfer Switches:

1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
2. Control Functions:

a. Automatic mode.

b. Test Mode: Simulates failure of primary/normal source.

c. Voltage and Frequency Sensing:

1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.

2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.

3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.

d. Outputs:

1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).

2) Auxiliary contacts; one set(s) for each switch position.

3) Signal before transfer (load disconnect) contacts; for selective load disconnection prior to transfer.

e. Adjustable Time Delays:

1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.

2) Transfer to alternate/emergency source time delay.

3) Retransfer to primary/normal source time delay.

4) Signal before transfer (load disconnect) contact time delay.

5) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.

f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.

g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.

3. Status Indications:

a. Connected to alternate/emergency source.

b. Connected to primary/normal source.

c. Alternate/emergency source available.

d. Primary/normal source available.

4. Automatic Sequence of Operations:

a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.

b. Where applicable, initiate signal before transfer (load disconnect) contacts at programmable time before transfer.

c. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.

d. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.

e. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

N. Remote Annunciators:

1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Transfer Switch Status Indications:

a. Connected to alternate/emergency source.

b. Connected to primary/normal source.

c. Alternate/emergency source available.

d. Primary/normal source available.

O. Interface with Other Work:

1. Interface with engine generators as specified in Section 26 32 13.
2. Interface with elevators as specified in Section 14 21 00 and 14 24 00.

2.3 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive transfer switches.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install transfer switches plumb and level.

F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Identify transfer switches and associated system wiring in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Prepare and start system in accordance with manufacturer's instructions.

C. Automatic Transfer Switches:

1. Inspect and test in accordance with NETA ATS, except Section 4.
2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.

a. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 32 13.

E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. See Section 01 79 00 - Demonstration and Training, for additional requirements.

B. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

D. Coordinate with related generator demonstration and training as specified in Section 26 32 13.

3.6 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

3.7 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:

1. Provide on-site response within 4 hours of notification.
2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION 26 36 00

SECTION 26 36 33 - CONNECTION CABINETS FOR PORTABLE GENERATORS AND LOAD BANKS - FOXFAB POWER SOLUTIONS

PART 2 PRODUCTS

1.1 MANUFACTURERS

A. Basis of Design: Foxfab Power Solutions; www.foxfab.com/#sle.

1.2 CONNECTION CABINETS

A. General Requirements:

1. Listed and labeled as complying with UL 1008.
2. NEMA EN 10250 Rating: Type 3R.
3. Bus Bar:

a. Material: Silver plated copper; aluminum not acceptable.

b. Equipment Ground Bus: Bonded to enclosure.

c. Isolated Ground Bus: Insulated from enclosure.

d. Ground Bus: 50 percent of phase size.

e. Neutral Bus: Rated to 100 percent of phase bus.

4. Input/Output Connectors for Portable Generators and Load Banks:

a. Camlocks: UL-listed, single-pole, 16 series, separable type; color coded according to system voltage requirements; rated 400 A; mounted on gland plate.

b. Provide bus bar connecting type; cabling or double set screw is not acceptable.

c. Prevent access when cabinet doors are closed.

d. Provided for each phase, ground, and neutral as required.

e. Bond connectors to enclosure and provide ground lug for connection of facility ground conductor.

5. Connectors for Permanent Generator: Factory-installed mechanical lugs, sized as required; located behind physical barrier.

B. Enclosure:

1. Accessibility:

a. Provide main access through hinged door that extends full height of enclosure.

b. Access for Portable Generator Cables with Female Cam-Style Plugs:

1) Wall-Mounted Units: Drawn-flange cable entry openings in bottom of enclosure.

2) Pad-Mounted Units: Hinged lower door.

c. Provide hinged-/flap door to cover cable openings; allow cable entry only after main access door has been opened.

d. Bottom Access Door: Run complete width of enclosure; not capable of opening with main door closed. Access bottom latch only from within enclosure.

2. Finish: Powder coated after fabrication.
3. Color: Wrinkle gray RAL 7035, unless otherwise indicated.
4. Hinges: Provide stainless steel, quick-release type for replacement of doors and to ease installation.
5. Door Lock: Three-point type; integrate pad lock hasp into door handle.
6. Provide phase indication mechanically etched into cam plate; stickers or labels are not acceptable.

C. Short Circuit and Withstand Rating: Minimum of 35 kAIC, unless otherwise indicated on drawings.

D. Circuit Breakers: Listed and labeled as complying with UL 489; removable for service and maintenance.

1.3 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Review and verify installation of components; verify electrical flow as indicated on drawings.

C. Manufacturer’s authorized technician to set long time, short time, instantaneous and ground fault protection settings on generator docking station circuit breakers in accordance with Engineer specifications or coordination study.

END OF SECTION 26 36 33

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 23 00 - Low-Voltage Switchgear.

C. Section 26 24 13 - Switchboards.

D. Section 26 24 16 - Panelboards.

1.3 ABBREVIATIONS AND ACRONYMS

A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.

B. SPD: Surge Protective Device.

1.4 REFERENCE STANDARDS

A. MIL-STD-220 - Method of Insertion Loss Measurement; 2009c (Validated 2024).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.6 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external

overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

1. SPDs with EMI/RFI filter: Include noise attenuation performance.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.7 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Field-Installed, Externally Mounted Surge Protective Devices:

1. ABB: www.electrification.us.abb.com/#sle.
2. Intermatic, Inc: www.intermatic.com/#sle.
3. nVent ERICO: www.nvent.com/#sle.
4. Schneider Electric: www.se.com/#sle.

B. Factory-installed, Internally Mounted Surge Protective Devices:

1. Same as manufacturer of equipment containing surge protective device, to provide complete listed assembly including SPD.

C. Substitutions: See Section 01 60 00 - Product Requirements.

D. Source Limitations: Provide surge protective devices produced by single manufacturer and obtained from single supplier.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mouonted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:

1. Wye Systems: L-N, L-G, N-G, L-L.
2. Delta Systems: L-G, L-L.
3. Single Split Phase Systems: L-N, L-G, N-G, L-L.
4. High Leg Delta Systems: L-N, L-G, N-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):

1. Equivalent to basis of design.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

1. Indoor clean, dry locations: Type 1.

H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:

1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.

I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.

1. Switchgear: See Section 26 23 00.
2. Switchboards: See Section 26 24 13.

2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).

a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.

6. Diagnostics:

a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.

b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

c. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

B. Basis of Design - Surge Protective Device: Surge Suppression, LLC (SSI); Advantage Series; Model SSLB (100 kA/phase, Type 2, I-n = 20 kA); www.surgesuppression.com/#sle.

1. Voltage: As indicated on drawings.

2. Features: Discrete "all-mode" protection (10 modes for 3-phase wye circuits); component-level thermal fusing; internal circuit board-mounted overcurrent fusing; 200 kAIC SCCR; 25 year warranty.
3. Include the following options:

    a. DIAGNOSTIC OPTIONS----->

    b. AC10 - Basic internal audible alarm with dry relay contacts.

    c. C - Form C dry relay contacts.

    d. ENCLOSURE AND DISCONNECT SWITCH OPTIONS----->

    e. (Only one of the following may be selected)

    f. D1 - NEMA 1, 2, 3, 3S, 4X, and 12 composite enclosure with integral non-fused disconnect switch, with external handle

    g. OTHER OPTIONS----->

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

E. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

F. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length.

Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

G. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

H. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Section 7.19.1.

D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.4 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 43 00

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires.

B. Emergency lighting units.

C. Exit signs.

D. Emergency power supply units.

1.2 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems.

B. Section 26 05 33.16 - Boxes for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 09 18 - Remote Control Switching Devices: Remote controls for lighting, including network lighting controls, programmable relay panels, and remote control switching relays.

E. Section 26 09 23 - Lighting Control Devices.

1. Includes automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
2. Includes lighting contactors.

F. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.

G. Section 26 56 00 - Exterior Lighting.

1.3 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.

B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

C. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

D. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information; 2019 (Reaffirmed 2025).

E. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2024.

F. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

H. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2025.

I. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.

J. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2023.

K. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2023.

L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

O. UL 1598 - Luminaires; Current Edition, Including All Revisions.

P. UL 1598C - Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits; Current Edition, Including All Revisions.

Q. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution upon request.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:

a. Include estimated useful life, calculated based on IES LM-80 test data.

b. Include IES LM-79 test report upon request.

2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.

D. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.

E. Field quality control reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

H. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide 3-year manufacturer warranty for LED luminaires, including drivers.

C. Provide 5-year pro-rata warranty for batteries for emergency lighting units.

D. Provide 10-year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

B. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 LUMINAIRES

A. Manufacturers:

1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
3. Hubbell Lighting, Inc; _____: www.hubbelllighting.com/#sle.
4. KURTZON Lighting, Inc; _____; www.kurtzon.com/#sle.
5. Lutron Electronics Company, Inc; _____: www.lutron.com/#sle.
6. Philips Lighting North America Corporation; _____: www.lightingproducts.philips.com/#sle.
7. Substitutions: See Section 01 60 00 - Product Requirements.

B. Provide products that comply with requirements of NFPA 70.

C. Provide products that are listed and labeled as complying with UL 1598, where applicable.

D. Provide products listed, classified, and labeled as suitable for the purpose intended.

E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

H. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.

2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

I. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

J. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.

1. LED Tape - General Requirements:

a. Listed.

b. Designed for field cutting in accordance with listing.

2. White LED Tape:

a. Correlated Color Temperature (CCT): _____ K unless otherwise indicated.

b. Color Rendering Index (CRI): Not less than 90.

K. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.3 EXIT SIGNS

A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.

1. Number of Faces: Single- or double-face as indicated or as required for installed location.
2. Directional Arrows: As indicated or as required for installed location.

B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.

1. Manufacturers:

a. Acuity Brands, Inc; _____: www.acuitybrands.com/#sle.

b. Cooper Lighting, a division of Cooper Industries; _____: www.cooperindustries.com/#sle.

c. Evenlite, Inc; _____: www.evenlite.com/#sle.

d. Hubbell Lighting, Inc; _____: www.hubbelllighting.com/#sle.

e. Philips Lighting North America Corporation; _____: www.lightingproducts.philips.com/#sle.

f. Substitutions: See Section 01 60 00 - Product Requirements.

C. Accessories:

1. Provide compatible accessory high-impact polycarbonate vandal shields where indicated.
2. Provide compatible accessory wire guards where indicated.

2.4 EMERGENCY POWER SUPPLY UNITS

A. Manufacturers:

1. Evenlite, Inc; _____: www.evenlite.com/#sle.
2. Iota Engineering, LLC; _____: www.iotaengineering.com/#sle.
3. Lithonia Lighting; _____: www.lithonia.com/#sle.
4. Philips Emergency Lighting/Bodine; _____: www.bodine.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.
6. Manufacturer Limitations: Where possible, for each type of luminaire provide emergency power supply units produced by single manufacturer.
7. Where specific manufacturer or model is indicated elsewhere in luminaire schedule or indicated on drawings, substitutions are not permitted unless explicitly indicated.

B. Description: Self-contained emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.

C. Compatibility:

1. Drivers: Compatible standard, energy saving, and dimming AC LED drivers, including those with end of lamp life shutdown circuits.

D. Operation: Upon interruption of normal power source, solid-state control automatically switches connected lamps to emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

E. Battery: Sealed maintenance-free high-temperature nickel cadmium unless otherwise indicated.

F. Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.

G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status and field selectable audible alert.

H. Operating Temperature: From 32 degrees F (0 degrees C) to 122 degrees F (50 degrees C) unless otherwise indicated or required for the installed location.

I. Accessories:

1. Provide compatible accessory remote combination test switch/indicator light where indicated.

2.5 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.

B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install products in accordance with manufacturer's instructions.

D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

G. Suspended Ceiling Mounted Luminaires:

1. Do not use ceiling tiles to bear weight of luminaires.
2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.

4. Secure pendant-mounted luminaires to building structure.
5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

H. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

I. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet (1.2 m) between supports.
4. Install canopies tight to mounting surface.
5. Unless otherwise indicated, support pendants from swivel hangers.

J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

K. Install accessories furnished with each luminaire.

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

M. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

N. Identify luminaires connected to emergency power system in accordance with Section 26 05 53.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.

C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.6 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 51 00

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior luminaires.

B. Poles and accessories.

C. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 33.16 - Boxes for Electrical Systems.

E. Section 26 06 50.16 - Lighting Fixture Schedule.

F. Section 26 09 23 - Lighting Control Devices.

1. Includes automatic controls for lighting including outdoor motion sensors, time switches, and outdoor photo controls.
2. Includes lighting contactors.

G. Section 26 27 26 - Wiring Devices: Receptacles for installation in poles.

H. Section 26 51 00 - Interior Lighting.

1.3 UNIT PRICES

A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

B. Exterior Lighting Unit:

1. Basis of Measurement: Each.
2. Basis of Payment: Includes concrete foundation, pole, and luminaire(s) with lamps and accessories.

1.4 REFERENCE STANDARDS

A. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals; 2013, with Editorial Revision (2025).

B. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing; 2023.

C. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

D. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.

E. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).

F. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information; 2019 (Reaffirmed 2025).

G. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2024.

H. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.

I. IES RP-8 - Recommended Practice: Lighting Roadway and Parking Facilities; 2025, with Errata (2026).

J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

K. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2000 (Reaffirmed 2006).

L. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2023.

M. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2023.

N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

O. UL 1598 - Luminaires; Current Edition, Including All Revisions.

P. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
2. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.6 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution upon request.

3. Provide structural calculations for each pole proposed for substitution.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:

a. Include estimated useful life, calculated based on IES LM-80 test data.

b. Include IES LM-79 test report upon request.

2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
3. Lamps: Include rated life and initial and mean lumen output.
4. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

D. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.

E. Field Quality Control Reports.

1. Include test report indicating measured illumination levels.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

H. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.7 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide 2-year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

B. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

H. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

I. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

J. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

K. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.

1. LED Tape - General Requirements:

a. Listed.

b. Designed for field cutting in accordance with listing.

c. Wet Location Applications: IEC 60529, IP 68 (waterproof) rated.

2. White LED Tape:

a. Correlated Color Temperature (CCT): _____ K unless otherwise indicated.

b. Color Rendering Index (CRI): Not less than 90.

L. Exposed Hardware: Stainless steel.

2.3 POLES

A. All Poles:

1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
2. Structural Design Criteria:

a. Comply with AASHTO LTS.

b. Wind Load: Include effective projected area (EPA) of luminaire(s) and associated supports and accessories to be installed.

1) Design Wind Speed: _____ miles per hour (_____ kph), with gust factor of 1.3.

c. Dead Load: Include weight of proposed luminaire(s) and associated supports and accessories.

3. Material: Steel, unless otherwise indicated.
4. Shape: Round straight, unless otherwise indicated.
5. Finish: Match luminaire finish, unless otherwise indicated.
6. Mounting Height: 16', unless otherwise indicated.
7. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
8. Unless otherwise indicated, provide with the following features/accessories:

a. Top cap.

b. Handhole, _____ size.

c. Anchor bolts with leveling nuts or leveling shims.

d. Anchor base cover.

e. Provision for pole-mounted weatherproof GFI receptacle where indicated.

B. Metal Poles: Provide ground lug, accessible from handhole or transformer base.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install products in accordance with manufacturer's instructions.

D. Install luminaires in accordance with NECA/IESNA 501.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

G. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

I. Pole-Mounted Luminaires:

1. Maintain the following minimum clearances:

a. Comply with IEEE C2.

b. Comply with utility company requirements.

2. Foundation-Mounted Poles:

a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 03 30 00.

1) Install anchor bolts plumb per template furnished by pole manufacturer.

2) Position conduits to enter pole shaft.

b. Install foundations plumb.

c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.

d. Tighten anchor bolt nuts to manufacturer's recommended torque.

e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.

f. Install anchor base covers or anchor bolt covers as indicated.

3. Grounding:

a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.

b. Provide supplementary ground rod electrode as specified in Section 26 05 26 at each pole bonded to grounding system as indicated.

4. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
5. Install weather resistant GFI duplex receptacle with weatherproof cover as specified in Section 26 27 26 in designated poles.

J. Install accessories furnished with each luminaire.

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

L. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

E. Measure illumination levels at night with calibrated meters to verify compliance with performance requirements. Record test results in written report to be included with submittals.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.6 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 56 00

SECTION 26 56 13 - POLES AND STANDARDS

PART 1 GENERAL

1.1 REFERENCE STANDARDS

A. IES RP-8 - Recommended Practice: Lighting Roadway and Parking Facilities; 2025, with Errata (2026).

1.2 RELATED DOCUMENTS

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

B. Division 26 Basic Electrical Requirements section applies to work specified in this section.

1.3 SUMMARY

A. The section includes not limited to, erecting, trenching, and installing poles and standards.

B. Applications of lighting poles and standards specified in this section include the following:

1. Automobile parking lots.
2. Pedestrian walkways.
3. Building entrances.

C. Related Sections: The following sections contain requirements that relate to this section:

1. Division 31 Section, “Earthwork” for excavation and backfilling of poles, standards, and foundations are specified in Division 2.
2. Division 3 Section, “Concrete” for embedding poles, and for pole foundations.
3. Wires/cables, raceways, and electrical boxes and fittings which are required in connection with electrical poles and standards are specified in Division 26.
4. Exterior lighting fixtures (luminaries) and brackets which are required in connection with electrical poles and standards are specified in another Division 26 section, “Lighting Fixtures”.

1.4 SUBMITTALS

A. Submit shop drawings, samples, and prototypes as specifically instructed herein and as follows:

B. Shop drawings shall include but not be limited to:

1. Submit fixture shop drawings in booklet form with a separate sheet for each fixture, assembled in “luminaire type” alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet.
2. Manufacturer’s dimensioned scale drawings showing in complete detail, the fabrication of all electrical pole standards, arms, and hardware including overall and detail dimensions, finishes, metal thickness, type, fabrication methods, support method, ballasts, hinges, gaskets, wind loading, wire/cable connections, and all other information to show compliance with the Contract Documents.

C. Samples

1. Partial pole standards samples may be requested for any or all of the fixtures specified.
2. Submit for approval samples called for by the Engineer when and where directed, and the components tagged with the name of the project. Samples will not be returned. Allow two weeks from the date of receipt for thorough examination and review by the Architect and Engineer.
3. All samples require a submission of material finish samples and component approval to be reviewed prior to shipment of any material to the project.
4. Electrical pole standards under the contract shall be identical with the approved sample. No portions or parts of the electrical pole standard used as a sample will be allowed to be installed on the project.
5. In the event the submissions are disapproved, the samples will be returned to the Contractor to immediately make a new submission of electrical pole standards meeting the contract requirements.
6. All costs associated for samples are to be paid by the Contractor. No additional cost to the owner for samples will be allowed.

D. Wiring Diagrams: Submit wiring diagrams for electrical poles and standards showing connections to electrical power panel feeders, switches, and controllers. Differentiate between portions of electrical wiring which are manufacturer-installed and portions which are field-installed.

E. Shop drawings and samples requested shall be submitted for approval before fabrication. Any material produced prior to the approval of shop drawings or samples, and not in conformance with the Contract Documents, shall be disapproved with the Contractor bearing full responsibility and cost.

F. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of the Architect. All variations must be clearly marked as such on the drawings submitted for approval.

G. Manufacturers not listed must be pre-qualified prior to bid. For approval of all electrical pole standards substitutions, the fabricator shall comply to specifications herein and as outlined below:

1. Manufacturer shall have not less than 5 years experience in design and manufacture of pole standards on the type and quality shown. Pre-qualification submissions must include a list of completed projects and dated catalogue pages and drawings indicating length of experience.
2. Printed physical, electrical and technical data clearly highlighted to show the differences between the proposed substitutions and the specified electrical pole standards.
3. The Architect and Engineer shall determine whether the prototype sample complies with the specifications and shall reserve the right to disqualify any bidders.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electrical poles and standards of types and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience with projects utilizing electrical pole and standard work similar to that required for this project.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local code requirement of the authority having jurisdiction and NEC Articles 220, 225, 250, 410, and 501 as applicable to installation, and construction of electrical poles and standards.
2. UL Compliance: Comply with UL standards, including UL 486A and 486B, pertaining to electrical poles and standards. Provide lighting components and fittings which are UL-listed and labeled.
3. ANSI/ASTM Compliance: Comply with applicable requirements of ANSI C 2, "National Electrical Safety Code", pertaining to construction and installation of lighting poles and standards.
4. AASHTO Compliance: Comply with applicable requirements of American Association of State Highway and Transportation Officials Standard LTS-1; "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals".
5. NEMA Compliance: Comply with NEMA Standards Pub/No's. LE 2 and TT 1 pertaining to electrical pole and standard units, materials, and installation.
6. IES Compliance: Comply with applicable requirements of IES RP-8, "Roadway Lighting", and RP-20, "Parking Facilities Lighting".

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver electrical pole and standard products, and fittings in factory-fabricated containers or wrapping, which properly protect products from damage.

B. Store electrical pole and standard products and fittings in original cartons in well-ventilated space protected from moisture, construction traffic and debris.

C. Handle electrical pole and standard products carefully to prevent breakage, denting and scoring finish. Do not install damaged units or components; replace with new.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of electrical pole and standard work with other work.

B. Sequence electrical pole and standard installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

PART 2 PRODUCTS

2.1 ELECTRICAL POLE STANDARDS

A. Metal Lighting Standards: Provide metal, raceway-type, lighting poles and standards, of sizes and types shown on schedules, comprised of shafts and tenon joints. Equip with grounding connections readily accessible from handhole or transformer base access doors; and constructed of the following materials and additional construction features:

1. Material: Cast aluminum for pedestrian scale poles, unless otherwise noted. Steel poles for parking lots and roadways, unless otherwise noted.
2. Configuration: Anchor base type with hand hole and cover where indicated.
3. Configuration: Transformer base type with access door and cover.
4. Metal Lighting Standard Accessories: Provide accessories for metal lighting standards, including anchor bolts, anchor bolt cover, as recommended by lighting standard manufacturer, of sizes and materials needed to meet erection and loading application requirements.

B. The pole, baseplate, and anchoring shall be designed by a professional structural engineer licensed in the state of Maine who is hired by the contractor / manufacturer to ensure pole base meets AASHTO requirements for the geographical project location.

C. Provide vibration dampener field or factory installed. Dampener shall be serpentine type, chain type are not permitted. Dampener shall be provided for the following types of poles:

1. Round Poles.
2. Square Poles.
3. Tapered Poles over 25 feet (762 cm).

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which pole standard, equipment and components are to be installed, and substrate which will support equipment. Notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ROADWAY AND PARKING AREA LIGHTING

A. Install pole and standard units and products in accordance with manufacturer’s written instructions, applicable requirements of NEC, NESC and NEMA standards, and with recognized industry practices to ensure that roadway and parking area lighting equipment fulfill requirements.

B. Utilize belt slings or rope (not chain or cable) to protect finishes when raising and setting finished poles and standards.

C. Set poles and standards plumb. Support adequately during backfilling, or when anchoring them to the foundations.

D. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling and conduit.

E. Fasten electrical lighting fixtures and brackets securely to structural supports, including poles/standards; and ensure that installed fixtures are plum and level.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B, and the National Electrical Code.

3.3 GROUNDING

A. Provide equipment grounding connections for poles and standards. Provide a ¾" x 10' copper rod at each pedestrian, parking lot and street lighting pole. Connect to a #6 bare copper ground wire. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

END OF SECTION 26 56 13

SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 2 PRODUCTS

1.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with the following. Where requirements differ, comply with most stringent.

a. TIA-569.

b. NFPA 70.

c. Requirements of authorities having jurisdiction.

2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.

a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit Supports: Straps and clamps suitable for conduit to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

D. Metal Channel/Strut Framing Systems:

1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
2. Comply with MFMA-4.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

F. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

END OF SECTION 27 05 29

SECTION 27 05 33.13 - CONDUIT FOR COMMUNICATIONS SYSTEMS

PART 2 PRODUCTS

1.1 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70 and TIA-569.

B. Provide conduit, fittings, supports, and accessories required for complete communications pathway.

C. Provide products listed, classified, and labeled as suitable for purpose intended.

D. Where conduit size is not indicated, size to comply with NFPA 70, TIA-569, and BICSI TDMM, but not less than applicable minimum size requirements specified. Where specified standards differ, comply with most stringent.

END OF SECTION 27 05 33.13

SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 2 PRODUCTS

1.1 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

A. Provide new cable tray system consisting of required components, fittings, supports, and accessories, as necessary for complete system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.

D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under service conditions at installed location.

E. Unless otherwise indicated, specified span/load ratings are based on safety factor of 1.5 and working load only (i.e., no additional concentrated static load), with ratings for metal cable tray systems in accordance with NEMA BI 50015.

F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values, with values for metal cable tray systems in accordance with NEMA BI 50015 including applicable allowable tolerances.

END OF SECTION 27 05 36

SECTION 27 10 00 - STRUCTURED CABLING

PART 2 PRODUCTS

1.1 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.

1. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
2. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F (0 to 60 degrees C) at relative humidity of 0 to 95 percent, noncondensing.
3. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

B. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.

1. Locate main distribution frame as indicated on the drawings.

C. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

1.2 IDENTIFICATION PRODUCTS

A. Comply with TIA-606.

END OF SECTION 27 10 00

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Communications entrance protection.

B. Communications cabinets, racks, frames, and enclosures.

C. Communications termination blocks and patch panels.

D. Communications cable management.

E. Communications rack-mounted power protection and distribution.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 53 - Identification for Electrical Systems.

C. Section 27 05 29 - Hangers and Supports for Communications Systems.

D. Section 27 05 36 - Cable Trays for Communications Systems.

E. Section 27 10 00 - Structured Cabling.

1.3 ABBREVIATIONS AND ACRONYMS

A. PDU: Power distribution unit.

B. RCDD: Registered communications distribution designer.

C. UPS: Uninterruptible power supply.

1.4 REFERENCE STANDARDS

A. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.

B. BICSI TDMM - Telecommunications Distribution Methods Manual, 15th Edition; 2024.

C. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; 2005e.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2024e.

F. TIA-568.3 - Optical Fiber Cabling and Components Standard; 2022e.

G. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.

H. TIA-607 - Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2024e.

I. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

J. UL 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits; Current Edition, Including All Revisions.

K. UL 497C - Protectors for Coaxial Communications Circuits; Current Edition, Including All Revisions.

L. UL 1363 - Relocatable Power Taps; Current Edition, Including All Revisions.

M. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

N. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways; Current Edition, Including All Revisions.

O. UL 2416 - Audio/Video, Information and Communication Technology Equipment Cabinet, Enclosure and Rack Systems; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate requirements for communications entrance protection with Communications Service Provider.
2. Coordinate arrangement of equipment with dimensions and clearance requirements.
3. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.6 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

C. Shop Drawings: Include plan views indicating locations of equipment and proposed cable routing. Include elevations and details of proposed equipment arrangements, prepared and approved by BICSI RCDD.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

E. Field quality control submittals.

F. Manufacturer's qualification statement.

G. Installer's qualification statement.

H. Operation and Maintenance Data: Include detailed information on system operation, equipment setup, replacement parts, and recommended maintenance procedures and intervals.

I. Specimen warranty.

J. Executed warranty.

K. Field Test Reports.

L. Project Record Documents: Prepared and approved by BICSI RCDD.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum 3 years of documented experience.

B. Installer Qualifications: Company having minimum 3 years of experience in installation and testing of type of system specified.

1. Employing BICSI RCDD.
2. Supervisors and installers factory certified by manufacturers of products to be installed.
3. Employing BICSI Registered Cabling Installation Technicians (RCIT) for supervision of work.

C. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL), and acceptable to authorities having jurisdiction.

D. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions and shop drawings.

1.8 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

C. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for duration below. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 COMMUNICATIONS ENTRANCE PROTECTION

A. Comply with:

1. BICSI TDMM.
2. NFPA 70.
3. TIA-607.

B. Building Entrance Termination:

1. Provide for each circuit entrance from serving communications distribution.
2. Listed and labeled as compatible with communications cable used.
3. Include cable termination and grounding points.
4. Include integral surge protection.

C. Surge Protection:

1. Line-Voltage Surge Protection:

a. Provide for each line voltage circuit serving communications entrance and related equipment.

b. Listed and labeled as complying with UL 1449.

2. Low-Voltage Surge Protection:

a. Provide for each communications circuit that enters or exits building.

b. Listed as complying with UL 497B or UL 497C.

c. Provide voltage and current ratings suitable for circuit to be protected.

2.2 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

A. Manufacturers:

1. Belden: www.belden.com/#sle.
2. CommScope: www.commscope.com/#sle.
3. Siemon Company: www.siemon.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. General Requirements:

1. Component Racks: EIA/ECA-310 standard 19 inches (482.6 mm) wide, unless otherwise indicated.
2. Cabinets: Steel construction with corrosion resistant finish.
3. Locks: Keyed alike.

C. Wall-Mounted Racks: Steel construction, hinged to allow access to back of installed components.

1. Minimum Static Load Rating: _____ lb (_____ kg).

D. Floor-Mounted Racks: Aluminum or steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.

1. Minimum Static Load Rating: _____ lb (_____ kg).

E. Freestanding Cabinets: Front and rear doors with locks; removable side panels with locks; vented top and rear door; adjustable leveling feet; cable access in roof and base; grounding bar.

1. Minimum Static Load Rating: _____ lb (_____ kg).

F. Wall-Mounted Cabinets: Front doors with locks, louvered side panels, top and bottom cable access, and ground lug.

1. Cover inside of cabinet back with plywood backboard.
2. Minimum Static Load Rating: _____ lb (_____ kg).
3. Top-mounted fan, capacity _____.
4. Provide duplex receptacle, NEMA 5-20R inside cabinet.

G. Accessories:

1. 1U blanking panels, for each enclosure.

2.3 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

A. Copper Cross-Connection Equipment:

1. Manufacturers:

a. Belden: www.belden.com/#sle.

b. CommScope: www.commscope.com/#sle.

c. Siemon Company: www.siemon.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Connector Blocks for Category 5e and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
3. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19-inch (482.6 mm) wide equipment racks; 0.09-inch (2.2 mm) thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.

a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.

b. Comply with TIA-568.2.

c. Include provisions for both T568A and T568B wiring configurations.

d. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.

e. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.

f. Provide incoming cable strain relief and routing guides on back of panel.

B. Fiber Optic Cross-Connection Equipment:

1. Manufacturers:

a. Belden: www.belden.com/#sle.

b. CommScope: www.commscope.com/#sle.

c. Siemon Company: www.siemon.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19-inch (482.6 mm) wide equipment racks; 0.09-inch (2.2 mm) thick aluminum.

a. Comply with TIA-568.3; match cable.

b. Adapters:

1) Maximum of 24 duplex adaptors per standard panel width.

c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.

d. Provide incoming cable strain relief and routing guides on back of panel.

e. Provide rear cable management tray at least 8-inches (203 mm) deep with removable cover.

f. Provide dust covers for unused adapters.

2.4 COMMUNICATIONS CABLE MANAGEMENT

A. Manufacturers:

1. Belden: www.belden.com/#sle.
2. CommScope: www.commscope.com/#sle.
3. Siemon Company: www.siemon.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Comply with BICSI TDMM for cable organization, minimizing strain relief, and cable bending limitations.

C. Comply with TIA-607 and NFPA 70 for bonding of metal parts with dedicated wiring or by using listed connections.

D. Cable Runway/Ladder Rack:

1. Provide complete cable runway system consisting of required components, fittings, supports, and accessories.
2. Material: Steel.

3. Minimum Static Load Rating: _____ lb (_____ kg).
4. Products:
    a. Belden; Belden Cable Runway: www.belden.com/#sle.
    b. Substitutions: See Section 01 60 00 - Product Requirements.

E. Fiber Raceways:

1. Description: Raceway system specifically designed for routing and protecting optical fiber cables; suitable for overhead, underfloor, and above-ceiling applications.
2. Provide complete fiber raceway system consisting of required components, fittings, supports, and accessories.
3. Material: Thermoplastic; nylon and PVC not acceptable.
4. Color: Yellow.
5. Joining Method: Mechanical; glue and solvents not acceptable.
6. Plenum rated; listed as complying with UL 2024.
7. Flammability: Comply with UL 94.
8. Minimum Cable Bend Radius: 2 inches (50 mm) throughout system.
9. Products:
    a. Belden; Belden Fiber Runway System: www.belden.com/#sle.
    b. Substitutions: See Section 01 60 00 - Product Requirements.

F. Horizontal/Vertical Cable Managers: Compatible with equipment racks.

1. Products:
    a. Belden; Belden BHH/BHV Series Horizontal/Vertical Managers: www.belden.com/#sle.
    b. Substitutions: See Section 01 60 00 - Product Requirements.

G. Noncontinuous Cable Supports and Cable Routing Assemblies: See Section 27 05 29.

H. Fabric Innerduct: See Section 27 10 00.

I. Hook-and-Loop Cable Ties: See Section 27 10 00.

2.5 COMMUNICATIONS RACK-MOUNTED POWER PROTECTION AND DISTRIBUTION

A. Manufacturers:

1. Eaton Corporation: www.eaton.com/#sle.
2. Schneider Electric; APC: www.se.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Rack Power Strips:

1. Description: UL 1363 listed and labeled, industrial grade power strip.
2. Provide AC rack-mounted power taps for equipment loads.
    a. Provide one per communications cabinet, rack, frame, or enclosure.

3. Mounting Orientation: Vertical.
4. Ratings: 120 V, 20 A.
5. Provide integral surge protection.
6. Number and Type of Load Receptacles: _____.
7. Cord Length: _____.
8. Input Plug and Receptacle Type: _____.

2.6 ACCESSORIES

A. Backboards: Interior grade plywood without voids, 3/4-inch (19 mm) thick; listed and labeled as fire-retardant.

1. Locations: As indicated on drawings
2. Size: As indicated on drawings.
3. Do not paint over listing label.

2.7 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements.

B. Verify ratings and configurations of system components.

C. Verify mounting surfaces are ready to receive system components.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to system where applicable.

E. Verify conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Comply with BICSI N1.

C. Wall-Mounted Racks and Cabinets:

1. Install to plywood backboards only, unless otherwise indicated.
2. Mount so height of topmost panel does not exceed 78-inches (1980 mm) above floor.

D. Floor-Mounted Racks and Cabinets: Permanently anchor to floor in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Comply with inspection and testing requirements of specified installation standards.

C. Provide equipment, tools, and supplies required to accomplish inspection and testing.

D. Submit detailed reports indicating inspection and testing results and corrective actions taken

3.4 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish; including repair of scratched or marred surfaces.

3.5 PROTECTION

A. Protect installed products from subsequent construction operations.

END OF SECTION 27 11 00

SECTION 27 51 19 - SOUND MASKING SYSTEMS

PART 2 PRODUCTS

1.1 SOUND MASKING SYSTEM REQUIREMENTS

A. Provide complete sound masking system consisting of noise generators, equalizers, amplifiers, loudspeakers, wiring, supports and other components necessary for meeting specified sound masking requirements in areas indicated on the drawings.

B. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system.
3. System Components Installed in Spaces Used for Environmental Air: Plenum rated; listed and labeled as complying with UL 2043, suitable for use in air-handling spaces.

C. Masking Sound Generation and Distribution Requirements:

1. Provide random or pseudo-random masking sounds with a repetitive pattern of not less than 24 hours.
2. Arrange system into masking control zones (independently controlled groups of loudspeakers) based on common installation conditions as indicated on the drawings.

a. Masking sound volume for each masking control zone to be adjustable in 0.5 dBA increments over a range of 35 dBA to 55 dBA at a distance of 3.3 feet (1 m).

D. System Control and Monitoring Requirements:

1. Provide security features to prevent unauthorized changes to or loss of system control settings.

a. Provide a locked enclosure or cabinet for readily accessible electronic components.

b. Provide password protection for access to programmable controls with a means for backing up settings.

END OF SECTION 27 51 19

SECTION 28 10 00 - ACCESS CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Access control system requirements.

B. Access control units and software.

C. Access control point peripherals, including readers and keypads.

D. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 08 71 00 - Door Hardware: Electrically operated door hardware, for interface with access control system.

C. Section 08 71 13 - Power Door Operators: Operator controllers for interface with access control system.

D. Section 14 21 00 - Electric Traction Elevators: For interface with access control system.

E. Section 14 24 00 - Hydraulic Elevators: For interface with access control system.

F. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

G. Section 26 05 33.13 - Conduit for Electrical Systems.

H. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

I. Section 27 10 00 - Structured Cabling: Data cables for access control system IP network connections.

J. Section 28 20 00 - Video Surveillance: For interface with access control system.

K. Section 28 31 11 - Building Intrusion Detection: For interface with access control system.

L. Section 28 46 00 - Fire Detection and Alarm: For interface with access control system.

1.3 DEFINITIONS

A. Access Control Cloud Services: Subscription-based hosted application utilizing Software as a Service (SaaS) delivery model in lieu of on-premises servers/software.

1.4 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 294 - Access Control System Units; Current Edition, Including All Revisions.

E. UL 1076 - Proprietary Burglar Alarm Units and Systems; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other installers to provide suitable door hardware as required for both access control functionality and code compliance.
2. Coordinate the placement of readers with millwork, furniture, equipment, etc. installed under other sections or by others.
3. Coordinate the work with other installers to provide power for equipment at required locations.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Access Control Cloud Services:

1. Subscription fees to be paid by Owner.
2. Obtain Owner approval of subscription fees and terms of service prior to submittal.

C. Preinstallation Meetings:

1. Conduct meeting with facility representative to review reader and equipment locations.
2. Conduct meeting with facility representative and other related equipment manufacturers to discuss access control system interface requirements.

1.6 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

D. Design Data: Standby battery/UPS calculations.

E. Certify that proposed system design and components meet or exceed specified requirements.

F. Evidence of qualifications for manufacturer.

G. Evidence of qualifications for installer.

H. Evidence of qualifications for maintenance contractor (if different entity from installer).

I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

J. Manufacturer’s detailed field testing procedures.

K. Field quality control test reports.

L. Maintenance contracts.

M. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

N. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

O. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

P. Software: One copy of software not resident in read-only memory.

Q. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Deliver blank credentials to Owner as directed.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.
2. The requirements of the local authorities having jurisdiction.
3. Applicable TIA/EIA standards.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with access control systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.

1. Contract maintenance office located within 100 miles (160 km) of project site.

E. Maintenance Contractor Qualifications: Same entity as installer.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Access Control Units:

1. Bosch Security Systems: www.boschsecurity.us/#sle.
2. Brivo: www.brivo.com/#sle.
3. Detex Corporation: www.detex.com/#sle.
4. DoorKing, Inc: www.doorking.com/#sle.
5. Honeywell International, Inc; Honeywell Security: www.buildings.honeywell.com/#sle.
6. LiftMaster: www.liftmaster.com/#sle.
7. Napco Access Pro, a subsidiary of NAPCO Security Technologies, Inc: www.napcoaccesspro.com/#sle.
8. Schneider Electric: www.se.com/#sle.
9. ZKTeco USA: www.zktecousa.com/#sle.
10. _____.
11. Substitutions: See Section 01 60 00 - Product Requirements.

B. Access Control Software:

1. Honeywell International, Inc; Honeywell Security: www.buildings.honeywell.com/#sle.
2. LiftMaster: www.liftmaster.com/#sle.
3. Napco Access Pro, a subsidiary of NAPCO Security Technologies, Inc: www.napcoaccesspro.com/#sle.
4. Schneider Electric: www.se.com/#sle.
5. Siemens Industry, Inc: www.siemens.com/#sle.
6. ZKTeco USA: www.zktecousa.com/#sle.
7. _____.

8. Substitutions: See Section 01 60 00 - Product Requirements.

C. Access Control Cloud Services:

1. Brivo: www.brivo.com/#sle.
2. Honeywell International, Inc; Honeywell Security: www.buildings.honeywell.com/#sle.
3. Napco Access Pro, a subsidiary of NAPCO Security Technologies, Inc: www.napcoaccesspro.com/#sle.
4. Schneider Electric: www.se.com/#sle.
5. _____.
6. Substitutions: See Section 01 60 00 - Product Requirements.

D. Readers and Keypads:

1. Bosch Security Systems: www.boschsecurity.us/#sle.
2. Brivo: www.brivo.com/#sle.
3. DoorKing, Inc: www.doorking.com/#sle.
4. Honeywell International, Inc; Honeywell Security: www.buildings.honeywell.com/#sle.
5. LiftMaster: www.liftmaster.com/#sle.
6. Napco Access Pro, a subsidiary of NAPCO Security Technologies, Inc: www.napcoaccesspro.com/#sle.
7. Schneider Electric: www.se.com/#sle.
8. ZKTeco USA: www.zktecousa.com/#sle.
9. _____.
10. Substitutions: See Section 01 60 00 - Product Requirements.

E. Source Limitations: Where possible, furnish system components and accessories produced by single manufacturer and obtained from single supplier.

2.2 ACCESS CONTROL SYSTEM REQUIREMENTS

A. Provide new access control system consisting of required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Battery Backup: Provide batteries/uninterruptible power supplies (UPS) as required for 120 minutes full operation.

C. Surge Protection:

1. Provide surge protection for readers and door strikes/locks.
2. Provide equipment power surge protection where electrical distribution system surge protection is not provided.

D. Access Control Points:

1. See article "ACCESS CONTROL POINT PERIPHERALS" below for device descriptions.

E. Computers Required:

1. See article "ACCESS CONTROL UNITS AND SOFTWARE" below for product descriptions.
2. Workstation Computer(s):

a. Quantity: One.

b. Location(s): To be determined.

c. Peripherals required for each workstation computer:

1) Mouse and keyboard.

2) Monitor(s): One.

3) Speakers (where not integral with monitor).

4) Alarm/report printer.

5) _____.

3. Badging Station Computer(s):

a. Quantity: One.

b. Location(s): To be determined.

c. Peripherals required for each badging station computer:

1) Mouse and keyboard.

2) Monitor(s): One.

3) Speakers (where not integral with monitor).

4) Badging printer.

5) Badging camera.

6) Badging signature tablet.

F. Interface with Other Systems:

1. Provide products compatible with other systems requiring interface with access control system.
2. Interface with electrically operated door hardware as specified in Section 08 71 00.

a. Capable of locking/unlocking/releasing controlled doors.

b. Capable of receiving input from integral door hardware switches.

3. Interface with elevators as specified in Section 14 24 00.

a. Capable of controlling access to elevator.

b. Capable of controlling elevator access to designated floors.

4. Interface with intrusion detection system as specified in Section 28 31 11.

a. Capable of affecting access for controlled doors for selected intrusion detection system events.

b. Capable of affecting intrusion detection system status for selected access control system events.

5. Interface with video surveillance system as specified in Section 28 20 00.
    a. Capable of affecting camera/video operation for selected access control system events.
6. Interface with fire alarm system as specified in Section 28 46 00.
    a. Capable of affecting access for designated doors for selected fire alarm system events.
7. Interface with HVAC controls as specified in Section _____.
    a. Capable of affecting operation of selected HVAC equipment for selected access control system events.
8. Interface with energy management system as specified in Section _____.
    a. Capable of affecting operation of selected HVAC equipment for selected access control system events.
9. Interface with lighting control system as specified in Section _____.
    a. Capable of affecting control of designated lighting for selected access control system events.

G. Provide products listed, classified, and labeled as suitable for the purpose intended.
1. Access Control Units and Readers: Listed and labeled as complying with UL 294.

2.3 ACCESS CONTROL UNITS AND SOFTWARE

A. Provide access control units and software compatible with readers to be connected.

B. Unless otherwise indicated, provide software and licenses required for fully operational system.

C. Access Control Unit:
1. Control Capability: _____ doors; _____ readers.
2. Database:
    a. Storage Capacity: _____ cardholders; _____ events.
    b. Quantity of Access Codes Supported: _____.
    c. Quantity of Holidays Supported: _____.
    d. Quantity of Time Codes Supported: _____.
    e. Quantity of Site Codes Supported: _____.
    f. Quantity of Card Formats Supported: _____.
3. Operating Modes Supported:
    a. Card only.

b. Card and PIN.

c. Duress.

4. Alarm Inputs: _____.
5. Output Relays: _____.
6. Features:

a. Dedicated tamper alarm input.

b. Dedicated power loss alarm input.

c. Supports database and event exporting.

d. Supports database backup.

e. _____.

2.4 ACCESS CONTROL POINT PERIPHERALS

A. Provide devices compatible with control units and software.

B. Provide devices suitable for operation under the service conditions at the installed location.

C. Readers and Keypads:

1. General Requirements:

a. Provide readers compatible with credentials to be used.

b. Color: To be selected by Architect from manufacturer's available standard colors.

c. Contactless Smart Card Readers:

1) Utilize 13.56 MHz RF communication with compatible credentials.

2) Utilize 64 bit authentication keys.

3) Support ISO compliant credentials.

4) Support data encryption.

d. Proximity Readers:

1) Utilize 125 kHz RF communication with compatible credentials.

2. Combination Reader:

a. Credentials Supported: Communicates with Bluetooth Low Energy (BLE) mobile credentials, 13.56 MHz smart cards, 125 kHz proximity cards, and near-field communication (NFC) credentials.

3. Contactless Smart Card Reader:
4. Biometric Hand Geometry Reader:
5. Proximity Reader:
6. Wiegand Insertion Reader:

D. Door Position Switches:

1. Magnetic Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors.
2. Contact Color: To be selected by Architect from manufacturer's available standard colors.

E. Request to Exit Devices:

1. Pushbuttons:
2. Motion Sensors: Passive infrared.

F. Door Locking Devices (Electric Strikes and Magnetic Locks): Comply with Section 08 71 00.

G. Alarm Sounders:

1. Minimum Sound Output: 85 db.

2.5 ACCESSORIES

A. Provide components as indicated or as required for connection of access control system to devices and other systems indicated.

B. Unless otherwise indicated, credentials to be provided by Contractor.

1. Provide credentials compatible with readers and control units/software to be used.

C. Unless otherwise indicated, network switches required for network connections to system components to be provided by Contractor.

D. Provide cables as indicated or as required for connections between system components.

1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP), minimum Category 5e, complying with Section 27 10 00.

E. Provide end-of-line resistors (EOLR) as required for supervision of hardwired connections.

F. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install access control system in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Wiring Method: Unless otherwise indicated, use cables (not in conduit).

1. Use suitable listed cables in wet locations, including underground raceways.
2. Use suitable listed cables for vertical riser applications.
3. Use listed plenum rated cables in spaces used for environmental air.
4. Install wiring in conduit for the following:

    a. Where required for rough-in.

    b. Where required by authorities having jurisdiction.

    c. Where exposed to damage.

    d. Where installed outside the building.

    e. For exposed connections from outlet boxes to devices.

5. Conduit: Comply with Section 26 05 33.13.
6. Conceal cables unless specifically indicated to be exposed.
7. Use power transfer hinges complying with Section 08 71 00 for concealed connections to door hardware.
8. Cables in the following areas may be exposed, unless otherwise indicated:

    a. Equipment closets.

    b. Within joists in areas with no ceiling.

9. Route exposed cables parallel or perpendicular to building structural members and surfaces.
10. Do not exceed manufacturer's recommended maximum cable length between components.

D. Provide grounding and bonding in accordance with Section 26 05 26.

E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

F. Identify system wiring and components in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Prepare and start system in accordance with manufacturer's instructions.

D. Program system parameters according to requirements of Owner.

E. Test for proper interface with other systems.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.6 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.7 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of access control system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

C. Provide trouble call-back service upon notification by Owner:

1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION 28 10 00

SECTION 28 15 23 - INTERCOM ENTRY SYSTEMS

PART 2 PRODUCTS

1.1 INTERCOM ENTRY SYSTEM

A. Provide new intercom entry system consisting of required equipment, conduit, boxes, wiring, connectors, hardware, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description:

1. System Type: Audio-video, IP network.

C. Accessories:

1. Provide components as indicated or as required for a complete operating system.
2. Wiring: Provide manufacturer's recommended cables as indicated or as required for connections between system components.
3. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

END OF SECTION 28 15 23

SECTION 28 18 00 - SECURITY ACCESS DETECTION EQUIPMENT

PART 2 PRODUCTS

1.1 WALK-THROUGH METAL DETECTORS

A. Comply with requirements of Owner.

B. Provide detectors suitable for environment where installed.

C. Alarm Indication: Visible and audible.

END OF SECTION 28 18 00

SECTION 28 20 00 - VIDEO SURVEILLANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Video surveillance system requirements.

B. Video recording and viewing equipment.

C. Cameras.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for camera poles.

B. Section 07 84 00 - Firestopping.

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

D. Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Section 26 05 33.13 - Conduit for Electrical Systems.

F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

G. Section 27 10 00 - Structured Cabling: Data cables for IP video surveillance system network connections.

H. Section 28 10 00 - Access Control: For interface with video surveillance system.

I. Section 28 31 11 - Building Intrusion Detection: For interface with video surveillance system.

1.3 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.

B. IEEE 802.3 - IEEE Standard for Ethernet; 2022 (Corrigendum 2024).

C. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NECA 303 - Standard for Installing and Maintaining Video Surveillance System; 2025.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:

1. Conduct meeting with facility representative to review camera and equipment locations and camera field of view objectives.
2. Conduct meeting with facility representative and other related equipment manufacturers to discuss video surveillance system interface requirements.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

1. Camera Poles: Include information on maximum supported effective projected area (EPA) and weight for design wind speed.

D. Design Data:

1. Standby battery/UPS calculations.
2. Video storage capacity calculations.

E. Certify that proposed system design and components meet or exceed specified requirements.

F. Camera Poles: Certify that products and associated supports comply with specified structural design criteria.

G. Evidence of qualifications for installer.

H. Evidence of qualifications for maintenance contractor (if different entity from installer).

I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

J. Manufacturer’s detailed field testing procedures.

K. Field quality control test reports.

L. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

M. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

N. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

O. Maintenance contracts.

P. Software: One copy of software not resident in read-only memory.

1.6 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.
2. Applicable TIA/EIA standards.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.

1. Contract maintenance office located within 100 miles (160 km) of project site.

E. Maintenance Contractor Qualifications: Same entity as installer.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Video Recording and Viewing Equipment and Software:

1. Axis Communications; _____: www.axis.com/#sle.
2. Bosch Security Systems; _____: www.boschsecurity.us/#sle.
3. Honeywell International, Inc; Honeywell Security: www.buildings.honeywell.com/#sle.
4. Pelco, Inc; _____: www.pelco.com/#sle.
5. VIVOTEK; _____: www.vivotek.com/#sle.
6. _____.
7. Substitutions: See Section 01 60 00 - Product Requirements.

B. Cameras:

1. Axis Communications; _____: www.axis.com/#sle.
2. Bosch Security Systems; _____: www.boschsecurity.us/#sle.
3. Honeywell International, Inc; Honeywell Security: www.buildings.honeywell.com/#sle.
4. Pelco, Inc; _____: www.pelco.com/#sle.
5. VIVOTEK; _____: www.vivotek.com/#sle.
6. _____.
7. Substitutions: See Section 01 60 00 - Product Requirements.

C. Source Limitations: Where possible, furnish system components and accessories produced by single manufacturer and obtained from single supplier.

2.2 VIDEO SURVEILLANCE SYSTEM

A. Provide new video surveillance system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description: IP system with connection to network (IP) cameras.

1. Video Storage Capacity: Suitable for storing video from all cameras for _____ days.
2. System Battery Backup: Provide batteries/uninterruptible power supplies (UPS) as required for _____ minutes full operation.
3. Surge Protection:

a. Provide surge protection for exterior cameras.

b. Provide equipment power surge protection where electrical distribution system surge protection is not provided.

C. Cameras Required:

1. See article "CAMERAS" below for product descriptions.

D. Video Recording and Viewing Equipment Required:

1. See article "VIDEO RECORDING AND VIEWING EQUIPMENT" below for product descriptions.
2. Room Number _____:
    a. Network Video Recorder (NVR) Type _____: One.
    b. Hybrid Digital Video Recorder (DVR) Type _____: One.
    c. Digital Video Recorder (DVR) Type _____: One.
    d. NVR server.
    e. NVR storage unit(s).
    f. Equipment rack.
    g. Uninterruptible power supply (UPS).
3. Room Number _____:
    a. Workstation Computer(s): One.
4. Room Number _____:
    a. Public View Monitor(s): One.
        1) Mounting Bracket.

E. Interface with Other Systems:

1. Provide products compatible with other systems requiring interface with video surveillance system.
2. Interface with access control system as specified in Section 28 10 00.
3. Interface with intrusion detection system as specified in Section 28 31 11.
    a. Capable of affecting camera/video operation for selected intrusion detection system events.
    b. Capable of affecting intrusion detection system status for selected video surveillance system events.

F. Provide products listed, classified, and labeled as suitable for the purpose intended.

G. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.3 VIDEO RECORDING AND VIEWING EQUIPMENT AND SOFTWARE

A. Provide video recording and viewing equipment compatible with cameras to be connected.

B. Network Video Recorders (NVRs):

1. Supports connection of network (IP) cameras.

2. Supports continuous and event-based recording.
3. Network Video Recorder Type _____:

    a. Capacity: _____ channels.

    b. Recording and Viewing Performance: _____ fps at _____ resolution.

    c. Storage Capacity: _____ TB.

    d. Removable Media: DVD-RW, USB.

    e. Network: Single 1 Gigabit Ethernet.

    f. Features:

        1) Supports PTZ camera control.

        2) Supports remote access via desktop and mobile device.

        3) _____.

    g. Products:

        1) Honeywell International, Inc; Honeywell Security; 35 Series: www.buildings.honeywell.com/#sle.

        2) Honeywell International, Inc; Honeywell Security; MAXPRO Series: www.buildings.honeywell.com/#sle.

        3) _____.

        4) Substitutions: See Section 01 60 00 - Product Requirements.

C. Hybrid Digital Video Recorders (DVRs):

1. Supports connection of both network (IP) and analog cameras.
2. Supports continuous and event-based recording.
3. Hybrid Digital Video Recorder Type _____:

    a. Capacity: Supports up to a combined total of _____ channels of analog and IP cameras.

    b. Recording Rate: _____ IPS (NTSC) at _____ resolution.

    c. Storage Capacity: _____ TB.

    d. Removable Media: DVD-RW, USB.

    e. Network: 10/100 base T Ethernet.

    f. Features:

        1) Supports alarm input/output.

        2) Supports bidirectional audio.

        3) Supports PTZ camera control.

        4) Supports remote access via desktop.

5) _____.

D. Digital Video Recorders (DVRs):

1. Supports connection of analog cameras.
2. Supports continuous and event-based recording.
3. Digital Video Recorder Type _____:

a. Capacity: _____ channels.

b. Recording Rate: Up to _____ IPS (NTSC).

c. Storage Capacity: _____ TB.

d. Removable Media: DVD-RW, USB.

e. Features:

1) Supports alarm input/output.

2) Audio inputs/outputs.

3) Supports PTZ camera control.

4) Supports remote access via desktop and mobile device.

5) _____.

E. Computers:

1. Workstation Computers: Unless otherwise indicated, workstation computer hardware not furnished by video surveillance system manufacturer to be provided by Contractor as part of work of this section, meeting video surveillance system equipment manufacturer's minimum requirements.

F. Software:

1. Unless otherwise indicated, provide all software and licenses required for fully operational system.
2. Video Management System:

a. Products:

1) Axis Communications; AXIS Camera Station Pro: www.axis.com/#sle.

2) Honeywell International, Inc; Honeywell Security; MAXPRO Series: www.buildings.honeywell.com/#sle.

3) Honeywell International, Inc; Honeywell Security; MAXPRO Video Management Software: www.buildings.honeywell.com/#sle.

4) Siemens Industry, Inc; Siveillance Video: www.siemens.com/#sle.

5) _____.

6) Substitutions: See Section 01 60 00 - Product Requirements.

G. Monitors:

1. Unless otherwise indicated, monitors to be provided by Contractor as part of work of this section.
2. Monitor: _____ inch (_____ mm) TFT active-matrix LCD.
    a. Resolution: Up to 1280 x 1024 (SXGA).

2.4 CAMERAS

A. Provide cameras and associated accessories suitable for operation under the service conditions at the installed location. Provide additional components (e.g. enclosures, heaters, blowers, etc.) as required.

B. Where not factory-installed, provide additional components (e.g. lenses, mounting accessories, etc.) as necessary for complete installation.

C. Network (IP) Cameras:

1. Signal-to-Noise Ratio: Not less than 50 dB.
2. Provide the following standard features:
    a. Automatic electronic shutter.
    b. Automatic gain control.
    c. Automatic white balance.
    d. Web-based interface for remote viewing and setup.
    e. Password protected security access.
3. Network (IP) Indoor Fixed Dome Camera Type _____:
    a. Camera Type: True day/night with IR cut filter.
    b. Image Sensor: 1/4 inch CMOS.
    c. Resolution: Up to 720p (1280 x 720).
    d. Frame Rate: Up to 30 frames per second (fps) at all available resolutions.
    e. Minimum Illumination: _____ lux color, _____ lux black and white.
    f. Lens: _____ - _____ mm varifocal; auto iris, manual focus and zoom; f _____.
    g. Video Streaming: Supports two simultaneous video streams using H.264 and H.264/MJPEG compression .
    h. Power: Power over Ethernet IEEE 802.3 or 24 VAC as indicated or as required.
    i. Features:
        1) Supports alarm input/output.
        2) Supports bidirectional audio.
        3) Camera tampering detection.
        4) Video motion detection capability.

5) _____.

4. Products:

a. _____.

D. Analog Cameras:

1. Signal-to-Noise Ratio: Not less than 50 dB.
2. Provide the following standard features:

a. Automatic electronic shutter.

b. Automatic gain control.

c. Automatic white balance.

d. _____.

3. Analog Indoor Fixed Dome Camera Type _____:

a. Camera Type: True day/night with IR cut filter.

b. Image Sensor: 1/3 inch CCD.

c. Effective Pixels: 768 x 494 (NTSC).

d. Horizontal Resolution: _____ TV lines.

e. Minimum Illumination: _____ lux color, _____ lux black and white.

f. Lens: _____ - _____ mm varifocal; auto iris, manual focus and zoom; f _____.

g. Video Output: 1.0 Vp-p, composite, 75 ohms (coax).

h. Power: 24VAC/12VDC.

i. Features:

1) Integral IR illumination: Provides illumination up to _____ feet (_____ m).

2) _____.

E. Lenses:

1. Where not factory-installed, provide lenses matched to cameras and the intended application.
2. Lens Type _____:

a. Type: Varifocal, _____ - _____ mm.

b. Iris Control: Auto.

c. Focus and Zoom: Manual.

d. Features:

1) IR corrected.

2) _____.

2.5 ACCESSORIES

A. Camera Enclosures: Where not factory-installed, provide camera enclosures suitable for operation under service conditions at installed location.

B. Camera Mounting Supports: Where not factory installed, provide mounting supports necessary for installation.

C. Camera Poles:

1. Provide poles suitable for cameras, supports, and accessories to be installed.
2. Pole Configuration: As indicated on drawings.
3. Pole Configuration:

a. Material: Use steel or aluminum.

b. Shape: Use square or round, straight or tapered.

c. Finish: Match light poles.

d. Mounting Height: _____, unless otherwise indicated.

e. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.

4. Provide ground lug, accessible from handhole.
5. Provide the following:

a. Top cap.

b. Handhole.

c. Anchor bolts with leveling nuts or leveling shims.

d. Anchor base cover.

e. Pole-top tenon, size as required for installed camera/bracket.

f. _____.

6. Products:

a. StrongPoles, LLC; SteadyMax Camera Poles: www.strongpoles.com/#sle.

b. StrongPoles, LLC; 4 Inch Square Camera Poles: www.strongpoles.com/#sle.

c. StrongPoles, LLC; 5 Inch Square Direct-Burial Camera Poles: www.strongpoles.com/#sle.

d. _____.

e. Substitutions: See Section 01 60 00 - Product Requirements.

D. Provide components as indicated or as required for connection of video surveillance system to devices and other systems indicated.

E. Provide components as indicated or as required for system power and network connections.

F. Provide video encoders as indicated or as required for connection of analog cameras to network (IP) video surveillance system.

G. Provide accessory controllers as indicated or as required for operator control.

H. Provide cables as indicated or as required for connections between system components.

1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP), minimum Category 5e, complying with Section 27 10 00.
2. Analog Video Connections:

a. Coaxial Cables: Copper center conductor and 95 percent bare copper braid shield, minimum RG59/U.

b. Coaxial Connectors: BNC crimp-on type.

I. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system where applicable.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.

B. Install products in accordance with manufacturer's instructions.

C. Provide required support and attachment in accordance with Section 26 05 29.

D. Wiring Method: Unless otherwise indicated, use cables (not in conduit).

1. Use suitable listed cables in wet locations, including underground raceways.
2. Use suitable listed cables for vertical riser applications.
3. Use listed plenum rated cables in spaces used for environmental air.
4. Install wiring in conduit for the following:

a. Where required for rough-in.

b. Where required by authorities having jurisdiction.

c. Where exposed to damage.

d. Where installed outside the building.

e. For exposed connections from outlet boxes to cameras.

5. Conduit: Comply with Section 26 05 33.13.
6. Conceal all cables unless specifically indicated to be exposed.
7. Cables in the following areas may be exposed, unless otherwise indicated:
8. Route exposed cables parallel or perpendicular to building structural members and surfaces.

E. Pole-Mounted Cameras:

1. Maintain the following minimum clearances:

a. Comply with IEEE C2.

b. Comply with utility company requirements.

2. Foundation-Mounted Poles:

a. Provide cast-in-place concrete foundations for poles as indicated; see Section 03 30 00.

1) Install anchor bolts plumb using template furnished by pole manufacturer.

2) Position conduits to enter pole shaft.

b. Install foundations plumb.

c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.

d. Tighten anchor bolt nuts to manufacturer's recommended torque.

e. Install nonshrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.

f. Install anchor base covers or anchor bolt covers as indicated.

3. Embedded Poles: Install poles plumb.

F. Provide grounding and bonding in accordance with Section 26 05 26.

G. Identify system wiring and components in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Prepare and start system in accordance with manufacturer's instructions.

C. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.

D. Program system parameters according to requirements of Owner.

E. Test for proper interface with other systems.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.6 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.7 MAINTENANCE

A. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of video surveillance system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

B. Provide trouble call-back service upon notification by Owner:

1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION 28 20 00

SECTION 28 31 11 - BUILDING INTRUSION DETECTION

PART 2 PRODUCTS

1.1 INTRUSION DETECTION SYSTEM REQUIREMENTS

A. Provide new intrusion detection system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Alarm Control Unit: New addressable alarm control panel located as indicated.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

1.2 ALARM CONTROL UNITS AND ACCESSORY EQUIPMENT

A. Alarm Control Panel: Modular construction.

1. Enclosure: Lockable; provide tamper protection.
2. Power Supply:

a. Primary Power: 120 VAC; provide suitable transformer/power supply; supervised for loss of AC power.

b. Secondary Power: Standby battery; provide suitable capacity for minimum standby time required by listing requirements, applicable codes, and authority having jurisdiction, but not less than four hours; provide suitable battery charger; supervised for low battery condition; protected from accidental reversal of battery leads.

B. Alarm Initiating Circuits: Supervised.

1. Hardwired Zones: Supports both normally closed and normally open conventional (non-addressable) initiating devices.
2. Addressable Zones: Supports addressable initiating devices and modules using multiplexed polling loops.

C. Alarm Notification Circuits: Supervised.

D. Communications Interfaces: Supervised.

1. Supports system reporting to central station receivers via integral interface or accessory interface modules using:

a. Telephone lines.

E. Keypads: Supervised.

1. Provide interface to alarm control unit for system control and remote annunciation.
2. Provide visual notification of system status and zone information.

3. Provide audible notification to indicate system status, entry/exit delay, and alarm situations; provide separate distinguishable sounds for alarm and trouble conditions.
4. Keypad Type: Only LCD or graphic touch screen keypads are acceptable. Do not use LED keypads.

    a. Graphic Touch Screen Keypads: Displays system status and zone information using plain English on graphic display; touch screen interface.

    b. LCD Keypads: Displays system status and zone information using plain English on alphanumeric display; illuminated keys.

F. Peripheral Devices: Supervised; provide tamper protection.

G. Output Relays:

1. Relay Modules: Form C relays (normally open and normally closed); provide tamper protection.
2. Programmable to respond to system events, according to defined scheduling, or by manual activation from keypad.

H. User Codes:

1. Each user code to be individually assignable to any defined authority level for configurable access to system features and functions.

I. Scheduling:

1. Provide time/calendar-based scheduling capability for automated system control.
2. Supports open/close schedules for control of arming/disarming and reporting.
3. Supports timed events including, but not limited to:

    a. Point bypass/unbypass.

    b. Relay activate/deactivate.

J. Event Log:

1. Stores system events including time, date, partition, zone, and user code where applicable.
2. Supports viewing of event log on keypads.

1.3 INITIATING DEVICES

A. Manufacturers: Same as manufacturer of alarm control units where possible.

B. General Requirements:

1. Provide devices suitable for intended application and location to be installed.
2. Outdoor Units: Weather resistant, suitable for outdoor use.
3. Addressable Systems:

    a. Addressable Devices: Individually identifiable by control unit.

    b. Provide suitable addressable modules for connection to conventional (non-addressable) devices and other components that provide a dry closure output.

END OF SECTION 28 31 11

SECTION 28 46 00 - FIRE DETECTION AND ALARM - NOTIFIER ONYX

PART 1 GENERAL

1.1 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide; Current Edition.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

C. UL 38 - Standard for Manual Signaling Boxes for Fire Alarm Systems; Current Edition, Including All Revisions.

UL 864 - Control Units and Accessories for Fire Alarm Systems; Current Edition, Including All Revisions.

D. UL 1971 - Standard for Signaling Devices for the Hearing Impaired; Current Edition, Including All Revisions.

E. UL 2572 - Mass Notification Systems; Current Edition, Including All Revisions.

F. UL 2610 - Commercial Premises Security Alarm Units and Systems; Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fire Alarm Control Unit and Accessory Equipment - Basis of Design: Notifier ONYX Series by Honeywell; www.securityandfire.honeywell.com/notifier/en-us/browseallcategories/control-panel/onyx-series/#sle.

B. Source Limitations: Where possible, furnish system components and accessories produced by one manufacturer and obtained from one supplier.

2.2 FIRE ALARM SYSTEM

A. Provide new fire alarm system consisting of required components (e.g., equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, and system programming) as necessary for complete operating system that provides functional intent indicated.

B. Products: Listed, classified, and labeled as suitable for purpose intended.

C. Power Sources:

1. Primary: Dedicated branch circuits from facility power distribution system.
2. Secondary: Storage batteries with capacity to operate system for period specified by NFPA 72.

D. Fire Alarm System Interfaces:

1. Fire alarm system interfaces to be listed to UL 864 unless otherwise indicated.
2. Descriptions below are intended to provide means for interface. See project sequence of operations, narrative, and input/output matrix for execution requirements.
3. Provide addressable monitor modules as indicated or as required for connection to addressable FACU. Unless devices are explicitly permitted to be connected together as one zone, provide separate addressable monitoring points for each device to be individually identifiable by addressable FACU.
4. Provide addressable relay module as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.

2.3 FIRE ALARM CONTROL UNIT AND ACCESSORY EQUIPMENT

A. Provide system listed and labeled as complying with agency listings and approval requirements as follows:

1. UL 864 (Control Units and Accessories for Fire Alarm Systems).
2. UL 2572 (Mass Notification Systems).
3. UL 2610 (Commercial Premises Security Alarm Units and Systems).
4. FM (AG) (FM approved).
5. City of Chicago.
6. Fire Department of New York (FDNY).
7. California State Fire Marshall (CSFM).

B. Provide cabinets and enclosures as indicated or as required to house system components.

C. Fire Alarm Control Unit (FACU):

D. Alarm Transmission and Integration:

2.4 FIRE ALARM SYSTEM INITIATING DEVICES

A. General Requirements:

1. Addressable Devices: Individually identifiable by addressable FACU; suitable for connection to FACU SLCs. Provide address-setting means on device using rotary switches with simple numerical indicators. Devices which require proprietary tools or dip switches to address device will not be accepted.
2. Conventional (nonaddressable) Devices: Provide addressable monitor modules or two-wire detector zone modules (See "Addressable Interface Modules" article for Basis of Design Products) as indicated or as required for connection to addressable FACU. Unless devices are explicitly permitted to be connected together as one zone, provide separate addressable monitoring point for each device in order to be individually identifiable by addressable FACU.
3. Provide devices and associated accessories suitable for intended application and location to be installed. Unless otherwise indicated, use addressable devices and addressable monitor modules only in clean, dry, indoor, nonhazardous locations.
4. Surface-Mounted Devices: Provide manufacturer's accessory surface mount backboxes or suitable outlet/device box.

5. Devices for Outdoor and Damp/Wet Locations: Weatherproof, suitable for outdoor use; provide manufacturer's accessory backboxes and enclosures in accordance with product listing.
6. Devices for Hazardous (Classified) Locations: Listed and labeled as suitable for classification of installed location.

B. Manual Fire Alarm Boxes (Pull Stations):

1. Description: Noncoded manual signaling boxes listed and labeled as complying with UL 38.
2. Alarm Initiation: Configured for general alarm initiation unless otherwise indicated; presignal stations (where indicated) require use of key to initiate general alarm.
3. Operation: Dual-action unless otherwise indicated; first requires pushing in then pulling down of lever.
4. Color: Red, in accordance with NFPA 72.
5. Station Reset: Requires use of key or tool.
6. Basis of Design Products:

a. Manual Pull Stations:

1) Notifier Model NBG-12LX addressable manual pull station, indoor rated, dual-action, key lock.

2.5 FIRE ALARM SYSTEM INTERFACE MODULES

A. Fire alarm system accessory equipment listed and labeled as complying with UL 864.

B. Provide addressable interface modules as indicated or required for fire alarm and nonfire alarm interfaced systems.

C. Individually identifiable by addressable FACU; suitable for connection to FACU SLCs. Provide address-setting means on device using rotary switches with simple numerical indicators. Devices which require proprietary tools or dip switches to address device will not be accepted.

D. Provide addressable modules suitable for connection to FACU SLCs.

E. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.

F. Addressable Monitor Modules: Unless devices are explicitly permitted to be connected together as one zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable FACU.

G. Addressable Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.

H. Basis of Design Products:

1. Addressable Monitor Modules:

a. Notifier Model FMM-1 addressable monitor module; single monitoring point, supervises one Class A or Class B circuit of conventional dry-contact input devices; uses single module address on SLC; mounts to nominal 4-inch (102 mm) square or 2-gang box, includes white finish cover.

2.6 FIRE ALARM SYSTEM NOTIFICATION APPLIANCES

A. Notification Appliances - General Requirements:

1. Provide signaling devices listed for fire-protective service and intended operating mode (public or private); suitable for connection to FACU notification NAC.
2. Provide addressable control modules as indicated or as required for selective control of notification appliances.
3. Provide notification appliances and associated accessories suitable for intended application and location to be installed. Use notification appliances only according to listed mounting (i.e., ceiling or wall mounted).
4. Surface-Mounted Notification Appliances: Provide manufacturer's accessory surface mount backboxes or suitable outlet/device box.
5. Notification Appliances for Outdoor and Damp/Wet Locations: Weatherproof, suitable for outdoor use; provide manufacturer's accessory backboxes and enclosures in accordance with product listing.
6. Notification Appliance Derating: Account for device derating adjustments in accordance with listing where applicable, including but not limited to the following.

a. Where accessory protective guards, and enclosures are utilized.

b. Where required by field conditions (e.g., ambient temperature).

7. Notification Appliances Colors:

a. See mounting configuration indicated by floor plan drawing symbols.

b. Wall-Mounted: Red.

c. Ceiling-Mounted: White.

B. Visible Notification Appliances:

1. Public Mode Operation: Listed and labeled as complying with UL 1971.
2. Strobes: Clear or nominal white lens with flash rate of 1 Hz unless otherwise indicated or required; xenon light source with maximum pulse duration of 0.2 seconds; candela rating as indicated.

C. Basis of Design Products:

1. Strobes:

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Install products in accordance with applicable requirements of NECA 1 (general workmanship).

C. Provide grounding and bonding in accordance with manufacturer's recommendations; see Section 26 05 26.

D. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.

E. Identify system wiring, components, and overcurrent protective devices for branch circuits serving fire alarm system; see Section 26 05 53.

END OF SECTION 28 46 00

SECTION 28 46 00 - FIRE DETECTION AND ALARM

PART 2 PRODUCTS

1.1 FIRE ALARM SYSTEM

A. General Requirements:

1. Provide new fire alarm system complying with NFPA 70, NFPA 72, NFPA 90A, and consisting of required equipment, conduit, cabinets, outlet boxes, wiring, connectors, hardware, supports, accessories, components, software, and system programming as necessary for complete operating system that provides functional intent indicated.
2. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:

    a. 36 CFR 1191 and ADA Standards.

    b. Requirements of AHJ.

    c. Applicable local codes.

    d. Contract Documents.

    e. NFPA 72; "should" is mandatory; where conflicts between requirements require deviation, identify deviations clearly on design documents.

3. Fire Alarm System Products:

    a. Listed, classified, and labeled as suitable for purpose intended.

    b. Installation Environments: Provide products suitable for their respective indoor and outdoor applications.

4. Provide fire alarm circuits in accordance with NFPA 70.

    a. Comply with methods of interconnecting FACUs in accordance with NFPA 72 and NFPA 70.

    b. Power Sources:

        1) Comply with requirements for power supplies of emergency systems in accordance with NFPA 70.

        2) Primary: Dedicated branch circuits from facility power distribution system.

        3) Secondary: Storage batteries with capacity to operate system for period specified by NFPA 72.

    c. Wiring and Wiring Methods:

        1) General Requirements:

            (a) Comply with requirements for wiring and wiring methods in accordance with NFPA 70.

(b) Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum-rated, listed and labeled as suitable for use in return air plenums.
(c) Special Occupancies: Comply with NFPA 70.
(d) Comply with NFPA 70 for wire and cable plenum, riser, general-purpose, limited-use, undercarpet, and underground applications.

2) Fire Alarm Circuits:

(a) Comply with NFPA 70 for conditions and types required for multiconductor cable systems.
(b) Non-Power-Limited Fire Alarm (NPLFA) Circuits:
(1) Provide dedicated NPLFA non-GFCI branch circuits for fire alarm equipment and marked by red identification in accordance with NFPA 70.
(c) Power-Limited Fire Alarm (PLFA) Circuits:
(1) Provide identification for PLFA circuits in accordance with NFPA 70.

5. Provide pathway class designations and pathway survivability, as defined in NFPA 72.

a. Provide monitoring of conductors and other signaling channels for integrity and circuit performance.

b. Pathway Class Designations:

1) Unless otherwise indicated or required, pathways to meet the following requirements:

(a) SLCs: Class B (star, tee-tap, multi-tap, with no return).
(b) IDCs: Class B (daisy-chain with EoL resistor device installed at end of circuit).
(c) NACs: Class B (daisy-chain with EoL resistor device installed at end of circuit).

B. Fire Alarm System Interfaces and Control Functions:

1. UL 864 listed unless otherwise indicated.
2. Descriptions below are intended to provide means for interface. See project SOOs, narrative, and input/output matrix for execution requirements.
3. Provide initiating devices, interfaces, and control functions for emergency control function interfaces in accordance with NFPA 72.
4. Provide monitoring of interconnected systems. Coordinate notification appliance alternate markings as indicated on drawings.

END OF SECTION 28 46 00

SECTION 31 10 00 - SITE CLEARING

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. Removing existing trees, shrubs, groundcovers, plants, and grass.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities procedures.
2. Division 01 Section "Temporary Tree and Plant Protection" for protecting trees remaining on-site that are affected by site operations.
3. Division 02 Section "Selective Structure Demolition" for partial demolition of buildings or structures undergoing alterations.
4. Division 31 Section "Earth Moving for Structures and Pavement" for soil materials, excavating, backfilling, and site grading.
5. Division 31 Section "Earth Moving for Utilities" for soil materials, excavating and backfilling.
6. Division 32 Section "Turf and Grasses, Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

C. Selective Clearing: Within the limits designated on the contract drawings (selective clearing should never take place within wetland areas), remove all, dead, dying, or diseased trees. Also trim as needed or remove trees that pose a hazard such as hanging over power lines or are leaning more than 30 degrees from vertical. Avoid/consult with the owner and/or engineer/architect on trees that fit this criteria but are considered specimen trees. (18” or larger caliper)

1.4 MATERIAL OWNERSHIP

A. Except other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Improvements on Adjoining Property: Performing site clearing on property adjoining Owner's property is prohibited.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises or adjoining property where indicated.

D. Utility Locator Service (Dig Safe): Notify Dig Safe (1-888-344-7233) for area where Project is located before site clearing operations has begun. Follow appropriate procedure and regulations as required.

E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner and Architect

3.2 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
4. Use only hand methods for grubbing within tree protection zone.
5. Chip removed tree branches and utilize for temporary erosion control measures. If can not be used, remove

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.4 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within tree protection zones.
3. Excess topsoil remains the property of the Owner.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.5 DISPOSAL

A. Disposal: Remove surplus soil material, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

2. Excess topsoil remains the property of the Owner.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING FOR STRUCTURES AND PAVEMENTS

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.

1.2 SUMMARY

A. Section includes performing site preparation, excavation, borrow, filling, backfilling, compaction, compaction testing, and finish grading necessary to construct the finished grades indicated for structures, pavements, and other on-grade slabs or site work. Requirements for excavating and backfilling for utility lines and storm drains are contained in Section 31 21 00, "Earth Moving for Utilities".

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities procedures.
2. Division 01 Section "Temporary Tree and Plant Protection" for protecting trees remaining on-site that are affected by site operations.
3. Division 32 Section "Turf and Grasses, Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
4. Division 31 Section "Earth Moving for Utilities" for soil materials, excavating, backfilling.
5. Division 31 Section "Dewatering" for requirements and guidelines for dewatering procedures.
6. Division 31 Section “Excavation Support and Protection" for requirements and guidelines for temporary excavation support.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
2. ASTM C136 2006 Sieve Analysis of Fine and Coarse Aggregates
3. ASTM D698 2007 (Rev. 1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))
4. ASTM D1557 2007 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))
5. ASTM D1586 2008 (Rev. A) Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
6. ASTM D2487 2006 (Rev. 1) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
7. ASTM D2729 2003 Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

8. ASTM D2855 1996 (Rev. 2002) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
9. ASTM D6938 2008 (Rev. A) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
10. ASTM D3212 2007 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
11. ASTM F402 2005 Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
12. ASTM F758 1995 (Rev 2007, E1) Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
13. ARMY CORPS OF ENGINEERS (COE)
14. COE EM-385-1-1 2008 Safety and Health Requirements Manual
15. State of Maine, Department of Transportation MDOT Standard Specifications, 11/2014 and amendments

B. Reference Standard Specifications: Materials and workmanship specified herein with reference to MDOT Maine State Standard shall be in accordance with the referenced articles, sections and paragraphs of the standard except that contractual and payment provisions do not apply.

1.4 DEFINITIONS

A. Coarse Aggregate: A layer of clean, poorly graded crushed rock, stone, or gravel having a high porosity which is placed beneath or adjacent to a building slab or structure with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below or adjacent a slab or structure.

B. Compaction: The process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum density obtained by the test procedure described in ASTM D698 or ASTM D1557 for general soil types abbreviated in this specification as " 95 percent ASTM D1557 maximum density".

C. Structural Fill: Granular fill material constructed to attain maximum bearing strength and minimize consolidation or differential settlement under a load.

D. Excavation: The removal of soil, rock, or hard material to obtain a specified depth or elevation.

E. Hard Material: Weathered rock, dense consolidated deposits or conglomerate materials, (excluding manmade materials such as concrete) which are not included in the definition of "rock" but which usually require the use heavy excavation equipment with ripper teeth or the use of jack hammers for removal. Material indicated in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 between 60 and 120 blows per foot is arbitrarily defined herein as "Hard Material".

F. Undisturbed Native Soil: Existing in place soil.

G. Lift: A layer (or course) of soil placed on top of a previously prepared or placed soil. Lift thickness shall be such that desired density is achieved throughout the lift thickness with 3 to 5 passes of the compaction equipment. Lift thickness shall not exceed 18 inches.

H. Rock: Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding three (3) cubic yard in volume. Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production. Material identified in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 greater than 120 blows per foot is arbitrarily defined herein as "Rock."

I. Ledge: Where used in this section, the term "Ledge" and "Rock" shall be considered the same and may be used interchangeably. The definition of "Ledge" shall be the same as "Rock" as defined in this section.

J. Soil: The unconsolidated surface material of the earth's crust resulting from the chemical and mechanical weathering of rock and organic material.

K. Subgrade: The material in excavation (cuts) and fills (embankments) immediately below any subbase, base, pavement, or other improvement. Also, as a secondary definition, the level below which work above is referenced.

L. Granular Fill: A dense, well-graded aggregate mixture of sand-gravel or crushed stone with suitable binder soil, placed on a subgrade to provide a suitable foundation for further construction.

M. Loam: In natural or undisturbed soil formations, the fine-grained, weathered material on the surface or directly below any loose or partially decomposed organic matter. Loam may be a dark-colored, fine, silty, or sandy material with a high content of well decomposed organic matter, often containing traces of the parent rock material. Gradation and material requirements specified herein apply to all loam references in this contract. The material shall be representative of productive soils in the vicinity.

N. Unsatisfactory Material: Existing, in-place soil or other material which can be identified as having insufficient strength characteristics or stability to carry intended loads in fill or embankment without excessive consolidation or loss of stability. Materials classified as PT, OH, or OL by ASTM D2487 are unsatisfactory. Unsatisfactory materials also include poor manmade fills, refuse, frozen material, uncompacted backfills for previous construction, unsound rock or soil lenses, or other deleterious or objectionable material. Also referred to as unsuitable material.

O. Fine Aggregate: Aggregate passing the 3/8-inch sieve and almost entirely passing the No. 4 sieve and predominantly retained on the No. 200 sieve, as determined by ASTM C125.

1.5 SUBMITTALS

A. Field Test Reports (Note - Reports shall be as specified herein and as per applicable ASTM Standards).

1. All aggregate, granular fill tests/gradation report. (Produced within the past year)
2. Subsurface drains, granular fill tests

3. Structural fill material tests/compaction report.
4. Compaction tests
5. General site fill/gradation report.
6. Stone dust/gradation report
7. As specified within this section.

1.6 DELIVERY AND STORAGE

A. Deliver and store materials in a manner to prevent contamination or segregation. Store synthetic fiber filter cloth to prevent exposure to direct sunlight in accordance with the manufacturer's written recommendations.

1.7 CRITERIA FOR BIDDING

A. Base bids on the following criteria (field verify existing conditions):

1. Surface elevations as indicated. If not indicated, verify in the field.
2. Pipes or other man-made obstructions, aside from those indicated on the drawings could be encountered. Field verify existing conditions.
3. The character of the material to be excavated or used for subgrade is as indicated. If not indicated, field verify. Hard material identified as conglomerate clay, sand, silt, or gravel, volcanic tuff, or consolidated calcareous marine sediments on the borings shall not be considered as rock and removal of such material shall not give cause for a claim for additional compensation regardless of hardness or difficulty in removing.
4. Removal of rock to the lines and grades indicated and required shall be done at the unit price bid (on the bid form) for "Mass or Trench Excavation". The unit price shall include all of the site contractors' costs associated with rock removals.
5. Ground water elevations indicated are based on observations at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.
6. Borrow material, Suitable backfill and fill material in the quantities required is not available at the project site.
7. Remove ledge material by drilling and use of expansion jacks for feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers, or as approved by the Architect/Engineer.
8. The unit price for mass or trench rock shall include the entire cost to drill, blast, remove and/or dispose of rock material as required.

1.8 SITE CONDITIONS

A. Utilities: Contact the Architect/Engineer 72 hours prior to construction for the location of all existing underground utilities. Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Contact the utility companies for locations of their utilities. Perform work adjacent to privately owned utilities in accordance with procedures outlined by the utility company. Excavation made with power-driven equipment is not permitted within two feet of known utilities or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work as

affected by the contract excavation until approval for backfill is granted by the Architect/Engineer. Report damage to utility lines or subsurface construction immediately to the utility Owner. Notify the Architect/Engineer immediately.

1.9 ADDITIONAL CRITERIA REGARDING ROCK REMOVAL

A. For concrete slabs and footings for the buildings, the following shall also apply:

1. When ledge is encountered, thoroughly clean off the ledge; contact the Architect for their inspection of such ledge.
2. Remove any ledge which is fractured or weathered or otherwise unsuitable (as determined by the Architect).
3. If the Architect determines that the rock is sound, then construct the footings on such sound rock as directed by the structural engineer of record, note additional provisions may need to be incorporated.
4. Footings shall be installed at the required minimum depth of cover as determined by the Architect/Engineer.

1.10 ROCK EXCAVATION

A. Boulders three (3) cubic yard or smaller shall be considered to be unclassified material regardless of location. Concrete and cut stone encountered in excavation in excess of three (3) cubic yard will be considered as "rock" as herein defined.

B. The word "trenches" as used herein shall mean excavation for utility lines having vertical sides whose depths exceed their width. Excavations for building foundation walls, retaining walls, and other structures other than utility lines shall not be classified as trench excavation.

C. When, during the process of excavation, rock is encountered, such material shall be uncovered and exposed and the Architect and/or Engineer shall be notified by the Contractor before proceeding further. The Contractor shall not proceed with the excavation of material claimed as rock until the material has been classified by the Architect or the Engineer. Failure on the part of the Contractor to uncover such material or notify the Architect or Engineer will forfeit the Contractor's right-of-claim for any compensation.

D. The Contractor shall employ at their expense a registered land surveyor acceptable to the Architect and/or Engineer to take cross sections of rock before removal of same and provide computations of cross sections within the limit of excavation lines. The contractor shall provide this information to the Architect/Engineer for review prior to beginning any rock removal.

E. Rock payment lines for building excavation will permit 6 inches of overblow in all directions from footing. Rock payment lines for trenches will permit 6 inches of overblow in all directions from bedding as shown in the Drawings (min. 36" width for payment).

F. For the purposes of computing compensation, the payment limits for excavation will be not over 18 inches beyond face of foundation wall in any horizontal direction. Excavations which are made beyond these limits shall be so executed at the Contractor's risk without compensation. Payments will not be made for excess excavations caused by methods of

operations used by the Contractor. Unauthorized excess excavations shall be at the Contractor's risk and expense.

G. All rock excavated shall be removed from the site and disposed of by the Contractor. Except where it can properly be reused on-site as described and indicated on the drawings.

H. All lines and grade work not presently established at the site shall be laid out by the Contractor in accordance with the Contract Documents. Establish permanent bench marks by employment of a registered land surveyor or professional Civil Engineer. Maintain all established bounds and bench marks and replace any which are destroyed or disturbed.

1.11 UNSUITABLE MATERIAL EXCAVATION

A. When, during the process of excavation, unsuitable material is encountered, such material shall be uncovered and exposed and the Architect and/or Engineer shall be notified by the Contractor before proceeding further. The Contractor shall not proceed with the excavation of material claimed as unsuitable until the material has been classified by a Geotechnical Engineer. Failure on the part of the Contractor to uncover such material or notify the Architect or Engineer will forfeit the Contractor's right-of-claim for any compensation.

B. The Contractor shall employ at their expense a registered land surveyor acceptable to the Architect and/or Engineer to take survey the surface of the unsuitable material before removal of same.

C. The geotechnical shall remain on site and monitor the removal of the material. The geotechnical engineer will direct the contractor when the extent of unsuitable material has been removed.

D. The surveyor retained will survey the post removal limits and provide computations of cross sections within the limit of excavation lines. Include a final cubic yardage of material removed. The contractor shall provide this information to the Architect/Engineer for review along with any requisition for payment. Contractor will not be reimbursed for the removal of material they placed as part of this project that has been deemed unsuitable. Similarly the contractor will not be paid for frozen material, or satisfactory material that has been compromised because it was not properly protected and allowed to freeze.

E. All unsuitable material excavated shall be removed from the site and disposed of by the Contractor following all local, state, and federal regulations.

PART 2 PRODUCTS

2.1 MATERIALS

A. Coarse Aggregate: Provide clean crushed stone or gravel similar to MDOT 703.02 with the following gradation (design size 3/4"):

1. Sieve % by Weight Passing
2. 1 inch 100
3. 3/4 inch 90 – 100

4. 1/2 inch 45 – 80
5. 3/8 inch 20 – 55
6. 1/4 inch 5 – 20
7. No. 4 0 – 10
8. No. 8 0 – 5
9. No. 200 1.5 max.

B. Gas Permeable Coarse Aggregate: Provide clean crushed stone or gravel per ASTM E1465 Type 2 Medium Aggregate with the following gradation:

1. Sieve % by Weight Passing
2. 1 inch 100
3. 3/4 inch 90 – 100
4. 1/2 inch 20 – 55
5. 3/8 inch 0 – 15
6. No. 4 0 – 5
7. Note: Void space must be at least 40%

C. Granular Fill: 4" minus aggregate, granular fill material to be as follows:

1. Provide a dense, well-graded aggregate meeting requirements stated in Section 70 3. 06 Type B, MDOT State Standard and as follows:

    a. The gradation of the entire sample (4" to No.200 sieve) shall meet the following gradation requirements:

        1) Sieve % by Weight Passing
        2) 4 inch 100
        3) 3-1/2 inch 90-100
        4) 3 inch 85-95
        5) 2-1/2 inch 25-80

    b. For the portion of the material sample that passes the 3 inch sieve the gradation of that part shall meet the distribution requirements in the following table:

        1) Sieve % by Weight Passing
        2) ½ inch 35-75
        3) ¼ inch 25-60
        4) No. 40 0-25
        5) No. 200 0-5

    c. Granular Fill shall not contain particles or rock that will not pass a 4 inch square mesh sieve. (4" Minus Material). Submit the gradation for the entire sample for review along with the portion that passes the 3inch sieve as indicated above.

D. Granular Base: 2" Minus Crushed granular base aggregate material to be as follows:

1. Provide a well-graded aggregate of crushed gravel, hard durable and uniform rock and shall consist of clean, angular fragments, free of objectionable matter including but not limited to rounded stone, silt and clay or other deleterious material. It is a 2" Minus Material and shall be similar to MDOT section 703.06, Type A aggregate and as follows:

    a. The gradation of the entire sample (2" to No. 200 sieve) shall meet the following gradation requirements:

        1) Sieve % by Weight Passing

        2) 2 inch 100

        3) 1 inch 85-95

        4) 1/2 inch 45-70

        5) 1/4 inch 30-55

        6) No. 40 0-20

        7) No. 200 0-6

    b. Granular base shall not contain particles of rock that will not pass a 2 inch square mesh sieve.

E. Granular Subbase: 6" Minus Granular subbase aggregate material to be as follows:

1. Provide a well-graded aggregate of screened or crushed gravel, hard durable and uniform rock and shall consist of clean, angular fragments, free of objectionable matter including but not limited to rounded stone, silt and clay or other deleterious material. It is a 6" Minus Material and shall be similar to MDOT section 703.06, Type D Aggregate and as follows:

    a. The gradation of the entire sample (6" to No. 200 sieve) shall meet the following gradation requirements:

        1) Sieve % by Weight Passing

    b. 6 inch 100

    c. 3 inch 65-90

    d. For the portion of the material sample that passes a 3 inch sieve the gradation of that part shall meet the distribution requirements in the following table:

        1) Sieve % by Weight Passing

        2) 1/4 inch 25-65

        3) No. 40 0-30

        4) No. 200 0-7

    e. Granular subbase to be non-frost susceptible. Granular subbase shall not contain particles of rock that will not pass a 6 inch square mesh sieve but will have particles larger than ¼" and should have particles larger than 3". Therefore

submit the gradation for the entire sample for review along with the portion that passes the 3inch sieve as indicated above.

F. Crushed Aggregate Subbase: Crushed Aggregate subbase to be as follows:

1. As per Maine DOT crushed aggregate subbase 703.06, Type D material (modified) and as follows:

a. The gradation of the part that passes a 3 inch sieve shall meet the following grading requirements:

1) Sieve % by Weight Passing

b. 1/4 inch 25-70

c. No. 40 0-30

d. No. 200 0-5

e. Granular subbase to be non-frost susceptible. Granular subbase shall not contain particles of rock that will not pass a 6 inch square mesh sieve.

G. Fine Aggregate: Fine Aggregate to be as follows:

1. As per MDOT 703.01, Fine Aggregate and as follows: Provide aggregate meeting requirements as described below.

1) Sieve % by Weight Passing

b. 3/8 inch 100

c. No. 4 95-100

d. No. 8 80-100

e. No. 16 50-85

f. No. 30 25-60

g. No. 60 10-30

h. No. 100 2-10

i. No. 200 0-5

H. Soil Materials: Provide materials free from debris, roots, wood, scrap materials, vegetable matter, refuse or frozen material. Maximum particle size permitted is 6-inches unless otherwise indicated on the drawings. Use excavated material from the site for the work indicated when material falls within the requirements specified herein.

I. Structural Fill: Provide materials classified as "Granular Fill" where indicated. Structural fill may also include non-frost susceptible "General Site Fill" located a minimum of 18" from foundation walls or adjacent to utilities, or a minimum of 12" away from building slabs, pavements or as indicated on the drawings or specified. System to be as follows:

1. Lifts to be a maximum of 9" thick.

2. Compact each lift to 95% compaction as determined by ASTM D1557.
3. Then add the next lift.

J. General Site Fill: Provide a soil material from the site or borrow that can be readily compacted to the specified densities and meeting requirements as follows:

1. Sieve % by Weight Passing
2. 6 inch 100
3. 3 inch 90-100
4. 1/4 inch 25-90
5. No. 40 0-50
6. No. 200 0-20
7. Materials shall be free of organic material, peat, clay, and other similar soft materials and may include blast ledge material up to 6" in diameter. This material shall not be used under buildings, pavements, or other structures unless otherwise indicated.

K. Loam: Loam shall be as covered in Section 32 92 00 - "Turf and Grasses."

L. Topsoil: Provide product classified as USDA loamy sand topsoil with 5%-8% humified organic matter and meeting the specification provided below. Topsoil from the project site may be appropriate but whether offsite or on-site the material should be tested for organic content and clay content (hydrometer test) The soil must be screened, loose, friable and shall be free of refuse, stones (greater than 2 inches), clogs, roots, and other undesirable foreign matter. See the gradation below:

1. Sieve Size % passing by weight
2. 4 75-95
3. 10 60-90
4. 40 35-85
5. 200 8-15

M. Crushed Stone: Crushed Stone shall be obtained from uniform and durable rock and shall consist of clean, angular fragments of quarried rock, free of objectionable matter and to be as follows:

1. As per MDOT 703.31, Crushed Stone and as follows:

    a. The stone, which is similar to railroad ballast, shall meet the following gradation requirements in the entire sample taken from the stockpile at the source:

        1) Sieve % by Weight Passing

    b. 2-1/2 inch 100

    c. 2 inch 90-100

    d. 1 inch 0-30

    e. 3/4 0-5

2.2 GEOTEXTILE FABRICS

A. As specified on drawings or in Section 31 30 00, "Sedimentation and Erosion Control Measures”

1. Fabric: woven polypropylene separation geotextile, possessing the following characteristics:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D 4632	N (lbs)	1402 (315)	1402 (315)
Grab Tensile Elongation	ASTM D 4632	%	12	
Trapezoid Tear Strength	ASTM D 4533	N (lbs)	503 (113)	503 (113)
CBR Puncture Strength	ASTM D 6241	N (lbs)	4005 (900)	
Apparent Opening Size (AOS) *	ASTM D 4751	mm (U.S. Sieve)	0.43 (40)	
Permittivity	ASTM D 4491	sec-1	0.05	
Flow Rate	ASTM D 4491	l/min/m2 (gal/min/ft2)	163 (4.0)	
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70	

2. * ASTM D 4751, AOS is a Maximum Opening Diameter Value

Physical Properties	Test Method	Unit	Typical Value	
Weight	ASTM D 5261	g/m2 (oz/yd2)	203 (6.0)	
Thickness	ASTM D 5199	mm (mils)	0.6 (25)	
Roll Dimensions (width x length)	--	m (ft)	3.8 x 110 (12.5 x 360)	5.3 x 78.7 (17.5 x 258)
Roll Area	--	m2 (yd2)	418 (500)	418 (500)
Estimated Roll Weight	--	kg (lb)	109 (240)	109 (240)

a. Acceptable products:

1) Tencate Mirafi 600X.

2) Propex Petromax 4598

3) Or approved equal

PART 3 EXECUTION

3.1 PROTECTION

A. Shoring and Sheeting: Provide shoring bracing, underpinning and sheeting where required. In addition to Section XXIII A and B of COE EM-385-1-1, and other requirements of this contract meet the following:

1. Prevent undermining of pavements, foundations and slabs.
2. Slope banks where space permits.
3. Where shoring and sheeting materials remain in place in completed work to prevent settlements or damage to adjacent structures or as directed, backfill the excavation to 3-feet below the finished grade and remove the remaining exposed portion of the shoring before completing the backfill.

B. Dewatering: Dispose of surface water, which may accumulate in open excavations, unfinished fills, or other low areas. Remove water by trenching where approved, pumping, or other methods to prevent softening of exposed surfaces. Surface dewatering plan shall include rerouting of any storm water runoff or natural drainage if necessary and shall comply with environmental requirements. Collect and dispose of surface and subsurface water encountered in the course of construction.

C. Water Removal: Remove water by pumping or other methods to prevent the softening of surfaces exposed by excavation. Before excavating below ground water level, place the dewatering system into operation. Lower the water levels at least one foot below the bottom and side slopes of the excavation. Relieve the hydrostatic pressure in pervious zones below the subgrade elevation in layered soils in order to prevent uplift. Use screens and gravel packs as necessary on the dewatering devices to prevent the removal of fines from the soil.

D. Operation and Performance: Operate the dewatering system continuously, 24-hours per day, 7-days per week until construction work below existing water levels is complete. Measure and record the performance of the dewatering system at the same time each day by use of observation wells and piezometers installed in conjunction with the dewatering system. After placement of initial slabs and backfill, the water level may be allowed to rise but at no time allow it to rise higher than one foot below the prevailing level of excavation or backfill. Have a back-up pump and system available for immediate use.

E. Protection and Restoration of Surfaces: Protect newly graded areas from traffic, erosion, and settlements. Repair and reestablish damaged or eroded slopes, elevations or grades and restore surface construction prior to acceptance. Protect existing streams, ditches and storm drain inlets from water-borne soil by means of straw bale dikes, filter fabric dams as indicated on the drawings or as required for good construction practices and to meet all environmental regulations.

1. Disposal of Excavated Material: Dispose of excavated material in such a manner that it will not obstruct the flow of runoff, streams, endanger a partly finished structure,

impair the efficiency or appearance of facilities, or be detrimental to the completed work.

2. Disposal of Rock. Remove all excess rock off-site.

3.2 SURFACE PREPARATION

A. Erosion Control: Perform as specified in Section 31 30 00, "Erosion and Sedimentation Control Measures".

B. Stockpiling Loam: Strip approved loam to a depth of 4 to 6-inches from the site where excavation or grading is indicated and stockpile separately from other excavated material. Stockpiled loam shall the Contractor's property. Locate loam so that the material can be used readily for the finished grading. Protect and store in segregated piles until needed.

C. Unsatisfactory Material: Remove organic matter, sod, muck, rubbish, and unsuitable soils under embankments, which are less than 3-feet in thickness and under pavements or slabs on grade. Typical depth of removal of such unsuitable material shall be 18 inches unless otherwise indicated.

D. Subgrade Proof Rolling: Proofrolling of subgrade soils shall be done only as noted on project drawings and with authorization of the Architect/Engineer. Proof rolling shall be done in the presence of the Architect/Engineer. Perform proof rolling only when weather conditions permit. Do not proof roll wet or saturated subgrades. Wet or saturated materials degraded by unauthorized proof rolling shall be replaced by the Contractor as directed by the Architect/Engineer at no cost to the Owner. Notify the Architect/Engineer 2-days prior to proof rolling.

3.3 EXCAVATION

A. Excavate to the contours and dimensions indicated. Keep excavations free from water while construction is in progress. Notify the Architect/Engineer immediately in writing in the event that it becomes necessary to remove rock, hard material, or other material defined as unsatisfactory to a depth greater than indicated and an adjustment in contract price will be considered in accordance with the General Conditions. Refill excavations cut below the depths indicated with granular fill and compact as specified herein. Excavate soil disturbed or weakened by the construction operations or soils soften from exposure to weather. Refill with granular fill and compact as specified herein.

B. Excavations for Structures and Spread Footings: Excavate to depth indicated on the drawings. If excavation is deeper than indicated on the drawings, then backfill with compacted structural fill to top of subgrade elevation prior to form placement. Lean concrete shall be used in place of compacted structural fill if backfill is over excavated sound rock as indicated on drawings.

C. Rock: Remove rock to the elevations indicated by drilling, or approved methods in such a manner that will leave foundation rock in an unshattered and solid condition. Roughen level surfaces and cut sloped surfaces into benches for bonding with concrete. Protect shale from conditions causing decomposition along joints or cleavage planes and other types of erosion. Removal of rock beyond the lines and grades indicated unless previously authorized by the Architect/Engineer will not be grounds for a claim for additional payment.

D. Shoring and Sheeting: Where required, shore and sheet excavations as described in the submitted plan, with various members sized and arranged to prevent injury to persons and damage to structures. Also arrange shoring and sheeting to preclude injurious caving during removal.

3.4 BORROW MATERIALS

A. Select borrow materials to meet requirements and conditions of the particular fill or backfill materials to be used. Obtain borrow materials from sources off of Owner property.

3.5 FILLING AND BACKFILLING

A. Subgrade Preparation: Step, bench, or break up sloped surfaces steeper than one vertical to 4-horizontal so that the fill material will bond with or be securely keyed to the existing material. Compact with equipment well suited to the soil being compacted. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

B. Fill and Backfill Beside Structures: Place required backfill material adjacent to structures and compact in a manner that prevents wedging action or eccentric loading upon or against the structures. Step or serrate slopes bounding or within areas to be backfilled to prevent sliding of the fill. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Do not place material on surfaces that are muddy, frozen, or contain frost. Do not use equipment for backfilling operations or for the formation of embankments against structures that will overload the structure. Backfilling against concrete will be done only after the concrete has attained at least 70% of its 28-day compressive strength and approval has been obtained from the Architect/Engineer.

C. Structural Fill: Place structural fill under spread footing, concrete slabs not pile supported, and pavements in loose lifts of 9-inches maximum. Do not place material on surfaces that are muddy, frozen, or contain frost. Compact with equipment well suited to the soil being compacted. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compact each lift as specified herein before placing the overlaying lift. Compaction shall be accomplished continuously over the entire area. Sufficient passes shall be made to ensure that specified density is obtained.

D. General Site Fill: Construct site fill, at the locations and to lines and grades indicated on the drawings. Use only approved materials in constructing fill upon the prepared subgrade. Place satisfactory material in horizontal lifts not exceeding 18-inches in loose depth. Do not place material on surfaces that are muddy, frozen, or contain frost. Compact with equipment well suited to the soil being compacted. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compact each lift as specified before placing the overlaying lift.

E. Final Backfill for Utilities: Construct backfill (final backfill) and general site fill for storm drains, manholes, utility lines, and other utility appurtenances using the material and

compaction requirements specified herein for the adjacent or overlaying work. Bedding and initial backfill requirements are specified in Section 31 21 00, "Earthwork for Utilities". Backfilling against concrete shall be done only after the concrete has attained at least 70% of its 28-day compressive strength and approval has been obtained from the Architect/Engineer.

F. Fill for Coarse Aggregate Under Slab: Place material over compacted subgrade. Compact and test the material. Then install the vapor barrier. Then install, compact and test the upper layer of material.

G. Weather Limitations: Fill and backfill shall not be constructed when weather conditions detrimentally affect the quality of the finished course. Place fill and backfill only if the atmospheric temperature is above freezing in the shade and is rising. Do not construct fill and backfill in the rain or on saturated subgrades. If weather conditions are windy, hot or arid, with high rate of evaporation, schedule the placement in cooler portions of the day and furnish equipment to add moisture to the fill or backfill during and after placement.

3.6 SUBGRADE GEOTEXTILE FABRIC (FOR SLOPED/FLAT SURFACES)

A. Place synthetic fiber geotextile fabric as indicated on drawings and as specified directly on prepared subgrade free of vegetation, stumps, and rocks larger than 2-inches diameter and other debris, which may puncture or otherwise damage the fabric. Repair damaged fabric by placing an additional layer of fabric to cover the damaged area a minimum of Two (2)-feet overlap in all directions. Overlap fabric at joints a minimum of two feet. Obtain approval of geotextile fabric installation before placing fill or backfill. Place fill or backfill on fabric in the direction of overlaps and compact as specified herein. Follow manufacturers recommended installation procedures.

3.7 COMPACTION

A. Compact each layer or lift of material specified so that the in-place density tested is not less than the percentage of maximum density specified. General fill below grassed areas shall be compacted to at least 90% of its maximum dry density as determined by ASTM D1557. Fill materials for all other areas shall be compacted to at least 95% of ASTM D1557 unless otherwise noted.

3.8 RESTORATION

A. Site Grading: Grade to finished grades indicated within 0.10-foot. Grade areas to drain water away from structures. Existing grades, which are to remain but are disturbed by the Contractor's operations shall be restored as directed by the Architect.

B. Finishing Subgrades Under Structures and Pavements: Finish the surface of top lift of fill or top of subgrade to the elevation and cross section indicated on the drawings. Finished surface shall be smooth and of uniform texture. Lightly scarify or blade the finished surface to bring the finished surface to within 0.05-foot of the indicated grade and to eliminate imprints made by compaction and shaping equipment. Surface shall show no deviations in excess of 3/8-inch when tested with a 10-foot straightedge.

C. Disposition of Surplus Material: Surplus or other soil material not required or suitable for filling, backfilling, or embankment shall be removed from Owner's property. Comply with the requirements of applicable environmental requirements.

D. Protection of Surfaces: Protect newly graded areas from traffic, erosion, and settlements that may occur in compliance with all applicable environmental regulations and as specified in the paragraph entitled "Protection and Restoration of Surfaces". Repair or reestablish damaged grades, elevations, or slopes prior to acceptance of work.

3.9 FIELD QUALITY CONTROL

A. All testing shall be performed by a qualified Independent Testing Laboratory acceptable to the Engineer and General Contractor at the Owner's expense unless otherwise indicated (see Section 01 40 00 - Quality Requirements).

B. In addition to the above tests, the Independent Testing Laboratory will perform additional density tests at locations and times requested by the Engineer.

C. Additional density testing will be required by the Engineer if the Engineer is not satisfied with the apparent results of the Site Contractor's compaction operation.

1. If the test results fail to meet the requirements of these specifications, the General Contractor shall undertake whatever action is necessary, at no additional cost to the Owner, to obtain the required compaction. The cost of retesting will be paid by General Contractor.
2. If the test results pass and meet the requirements of these Specifications, the cost of the initial testing service will be borne by the Owner, but no additional cost will be considered for delays in the performance of the work.

D. Tests: Test fill, granular base, backfill, granular subbase, granular fill and coarse aggregate as specified herein and as follows:

1. For gradation (sieve analysis) fine and course, as per ASTM C136 and D422.
2. For moisture density as per ASTM D1557.
3. Also perform tests as per Table IV.
4. For areas under slab on grade: First, nuclear density test the granular fill material under the vapor barrier as per ASTM D6938. Then density test the granular fill which is installed between the slab and the vapor barrier.
5. TABLE IV
6. TESTS

Material Type	Location of Material	Minimum Field Density Test Frequency
Fills and Backfills	Structures (adjacent to)	One test per side of structure per lift.
Controlled Fills	Primary roadways and structures (under)	One test per lift per 2,000 sq. ft.
Embankments of Borrow	Any	One test per lift per 10,000 sq. ft.

Borrow	Any	One test per lift per 10,000 sq. ft.

1) —End of Table IV—

7. If the gradation test results fail to meet the requirements of the specifications, or if the sample is noticeably different when delivered to the site, or if the stockpile source changes either before or during construction, or if compaction of the material is unable to meet the compaction requirements, the General Contractor shall undertake whatever action is necessary, at no additional cost to the Owner, to obtain the required gradation. The cost of the retesting will be paid by the General Contractor.

    a. Additionally the contractor reserves the right to test the material for proper gradation in advance of the project's notice to proceed, however the owner reserves the right to request the material be retested once the materials has arrived on site, especially including but not limited to if one of the following has occurred; more than 3 months have passed since the initial material testing had been done, if the material arriving on site for placement appears to not meet spec, if the supplier stockpile has been reworked or if the stockpile supplier has changed, or if mixing of on-site stockpiles has occurred, or other similar occurrences which may affect the products integrity or as noted above. The contractor incurs the cost of this additional testing.

E. Structural Fill: Method of in-place density tests shall be in accordance with paragraph "Tests". Acceptance of the compacted material shall be determined in each location by the results of a minimum of two consecutive tests. The average of two tests shall equal or exceed the specified density. The location of the tests for each compacted layer will be randomly selected by the Architect/Engineer.

1. Acceptance: The average of field density test results in each fill area shall meet or exceed the specified density requirements and no individual test shall be more than 3% below specified density.

END OF SECTION 31 20 00

SECTION 31 21 00 - EARTH MOVING FOR UTILITIES

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.

1.2 SUMMARY

A. Section includes performing site preparation, excavation, borrow, filling, backfilling, compaction, compaction testing, and finish grading necessary to construct to the specified finished grades indicated for utilities. The work covered by this section shall terminate at a point approximately 10 feet from the building, unless otherwise indicated on the drawings.

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities procedures.
2. Division 01 Section "Temporary Tree and Plant Protection" for protecting trees remaining on-site that are affected by site operations.
3. Division 32 Section "Turf and Grasses, Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
4. Division 31 Section "Earth Moving for Pavements and Structures" for soil materials, excavating, backfilling, and site grading.
5. Division 31 Section "Dewatering" for requirements and guidelines for dewatering procedures.
6. Division 31 Section “Excavation Support and Protection" for requirements and guidelines for dewatering procedures.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
2. ASTM C33 2008 Standard Specification for Concrete Aggregates
3. ASTM D698 2007 (Rev. 1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
4. ASTM D1556 2007 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
5. ASTM D1557 2007 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))
6. ASTM D1586 2008 (Rev. A) Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
7. ASTM D6938 2008 Rev. A) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
8. ASTM D4253 2000 (Rev. 2006) Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

9. ASTM D4254 2000 (Rev. 2006, E1) Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
10. ARMY CORPS OF ENGINEERS (COE) WATERWAYS EXPERIMENT STATION
11. COE EM-385-1-1 2008 Safety and Health Requirements Manual
12. FEDERAL SPECIFICATIONS (FS)
13. FS UU-P-268 1977 (Rev. G) (Amd. 3) Paper, Kraft, Wrapping
14. STATE OF MAINE, DEPARTMENT OF TRANSPORTATION
15. State of Maine, Department of Transportation MDOT Standard Specifications, 12/2002 and amendments

B. Materials and workmanship specified herein with reference to MDOT State Standard shall be in accordance with the referenced articles, sections, and paragraphs of the standard except that contractual and payment provisions do not apply.

1.4 DEFINITIONS

A. Backfill: Material used in refilling a cut, trench or other excavation.

B. Cohesive Materials: Soils classified by ASTM D2487 as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesive only when fines have a plasticity index greater than zero.

C. Cohesionless Materials: Soils classified by ASTM D2487 as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines have a plasticity index of zero.

D. Compaction: The process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum density obtained by the test procedure described in ASTM D698 or ASTM D1557 for general soil types or ASTM D4253 or ASTM D4254 (Relative Density) for isolated cohesionless materials, abbreviated in this specification as " _____ percent ASTM D1557 maximum density."

E. Pipe Bedding: A dense, well-graded aggregate mixture of sand, or coarse aggregate, as indicated (mixed individually, in combination with each other, or with suitable binder soil) placed on a subgrade to provide a suitable foundation for pipe.

F. Hard Material: Weathered rock, dense consolidated deposits, or conglomerate materials (excluding man made materials such as concrete) which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal. Material indicated in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 between 60 and 120 blows per foot is arbitrarily defined herein as "Hard Material".

G. In-Situ Soil (Undisturbed Earth): Existing in place soil.

H. Lift: A layer (or course) of soil placed on top of subgrade or a previously prepared or placed soil in a fill or backfill.

I. Porous Fill: A granular soil material having a large void ratio when placed and compacted, allowing a free flow of fluid to or from the surrounding soil, with no more than 5% of the material passing the 1/2-inch No. 100 Sieve.

J. Refill: Material placed in excavation to correct overcut in depth.

K. Rock: Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding three (3) cubic yard in volume. Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production. Material identified in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 greater than 120 blows per foot is arbitrarily defined herein as "Rock."

L. Loam: In natural or undisturbed soil formations, the fine-grained, weathered material on the surface or directly below any loose or partially decomposed organic matter. Loam may be a dark-colored, fine, silty, or sandy material with a high content of well decomposed organic matter, often containing traces of the parent rock material. Gradation and material requirements specified herein apply to all Loam references in this contract. The material shall be representative of productive soils in the vicinity.

M. Unyielding Material: Rock rib, ridge, rock protrusion, or soil with cobbles in the trench bottom requiring a covering of finer grain material or special bedding to avoid bridging in the pipe or conduit.

N. Unsatisfactory Material: In-Situ soil or other material, which can be identified as having insufficient strength characteristics or stability to carry intended loads in the trench without excessive consolidation or loss of stability. Also backfill material, which contains refuse, frozen material, large rocks, debris, soluble particles, and other material, which could damage the pipe or cause the backfill not to compact. Materials classified as PT, OH, or OL by ASTM D2487 are unsatisfactory.

O. Unstable Material: Material in the trench bottom, which lacks firmness, to maintain alignment and prevent joints from separating in the pipe, conduit, or appurtenance structure during backfilling. This may be material otherwise identified as satisfactory which has been disturbed or saturated.

1.5 SUBMITTALS

A. Factory Test Reports (produced within the past year)

1. Trench backfill material tests
2. Pipe bedding material tests

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver and store materials in a manner to prevent contamination, segregation, freezing, and other damage. Store synthetic fiber filter fabric to prevent exposure to direct sunlight.

1.7 CRITERIA FOR BIDDING

A. Base bids on the following criteria:

1. Surface elevations are as indicated. If not indicated, verify in the field.
2. Pipes or other man-made obstructions, other than those indicated, could be encountered. Field verify existing conditions.
3. The character of the material to be excavated or found in the trench is as indicated. If not indicated, field verify. In addition to rock as indicated and as defined in paragraph entitled "Definitions," hard material in the form of conglomerate clay, sand, silt, gravel, volcanic tuff, or consolidated calcareous marine sediments could be encountered. Remove such hard material to the lines and grades indicated regardless of the hardness or quantity. Such material shall not be considered rock.
4. Removal of rock to the lines and grades as required shall be done at the unit price on the bid form for "Mass or Trench Excavation". The unit price shall include all of the site contractors' costs associated with rock removals.
5. Ground water elevations indicated are those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.
6. Borrow material, Suitable backfill, and bedding material in the quantities required is not available at the project site.

1.8 PROTECTION

A. Utilities: Movement of construction machinery and equipment over pipes and utilities during construction shall be at the contractor's risk. Perform work adjacent to utilities as indicated in accordance with procedures outlined by utility company. Excavation made with power-driven equipment is not permitted within two feet of known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Architect/Engineer. Report damage to utility lines or subsurface construction immediately to the Architect/Engineer.

1.9 ADDITIONAL REQUIREMENTS

A. Local Standards: All water line and sewer work shall meet local municipal standards, and local utility company standards; furnish written evidence that such standards have been met.

B. Road Crossings: Contractor to obtain and pay for all required road crossing permits (including MDOT and local areas when required). Perform all work for street resurfacing which is required for such permits.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. Provide soil materials as specified below free of debris, roots, wood, scrap material, vegetable matter, refuse, soft unsound particles, ice, or other deleterious and objectionable materials.

B. Backfill: Bring trenches to grade indicated on the drawings using material excavated on the site of this project. When at all possible provide borrow as necessary. Borrow shall be in accordance with backfill requirements of this paragraph and approved for use by the Architect/Engineer prior to placement. This material will be considered unclassified and no testing other than for compaction will be required before use as backfill classified as GW by ASTM D2487 with a maximum particle size of 3-inches conforming to gradation MDOT 703.06.

C. Special Backfill for Structures and Pavements: Backfill trenches under roads, structures, and paved areas as specified in Section 31 20 00, "Earth Moving For Structures and Pavements" with material conforming to MDOT 703.06.

D. Sand: Sand shall consist of natural sand or, when approved by the Architect, other inert materials with similar characteristics or combinations thereof, having strong, durable particles. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix without permission of the Architect. All sand shall be free from injurious amounts of organic impurities. Should the sand, when subjected to the calorimetric test for organic impurities, AASHTO T21 (ASTM C40), produce a color darker than the reference standard color solution (laboratory designation Plate III), it shall be rejected. The sand shall be well graded from coarse to fine and shall meet the following grading requirements when tested according to AASHTO T11 and AASHTO T27.

1. Sieve Percentage by Weight
2. Designation Passing Square Mesh Sieves
3. 3/8 inch 100
4. No. 4 95-100
5. No. 8 70-95
6. No. 16 45-80
7. No. 30 25-55
8. No. 50 10-30
9. No. 100 2-10
10. No. 200 0-5

E. Backfill for Underdrainage Systems - Refer to Section 33 42 00.

F. Borrow: Provide materials meeting requirement for general site fill. Obtain borrow materials in excess of those furnished from excavations specified herein from sources off Owner property.

G. Pipe Bedding: Provide material for pipe bedding as indicated.

2.2 GENERAL SITE FILL, BACKFILL AND EMBANKMENT MATERIAL

A. Provide a soil material from the site or borrow that can be readily compacted to the specified densities. Materials shall be free of organic material, peat, clay, and other similar soft materials.

2.3 LOAM

A. Loam shall be as covered in Section 32 92 00 - "Turf and Grasses."

2.4 GRANULAR FILL

A. Granular fill shall be as covered in Section 31 20 00, "Earth Moving for Structures and Pavements".

2.5 CONCRETE PIPE CRADLES (THRUST BLOCKS) OR ARCHES

A. Provide concrete pipe, cradles (thrust blocks) where indicated on the drawings and where unstable conditions are encountered conforming to lines and dimensions indicated. Provide concrete in accordance with Section 03 30 00, "Cast-In-Place Concrete." with the concrete having a 28-day compressive strength of 3,000 psi minimum.

2.6 BURIED WARNING AND IDENTIFICATION TAPE

A. Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3-inch-minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil. Typical Warning Tape Color Codes (Refer to drawings for type needed)

1. Yellow: Electric
2. Yellow: Gas, Oil, Dangerous Materials
3. Orange: Telephone and Other Communications
4. Blue: Water Systems
5. Green: Sewer Systems
6. White: Steam Systems
7. Gray: Compressed Air

B. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

C. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.7 MATERIAL FOR RIP-RAP

A. Bedding material, Filter fabric, and rock conforming to these requirements and as indicated.

B. Bedding Material: Consisting of sand, gravel, or crushed rock, well graded, with a maximum particle size of 2 inches. Material shall be composed of tough, durable particles. Fines passing the No. 200 standard sieve shall have a plasticity index less than six. Refer to

Section 31 20 00, "Earth Moving for Structures and Pavements" for stone materials and bedding materials requirements.

C. Rock: Rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Rock fragments shall be free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. The size of the fragments shall be such that no individual fragment exceeds a weight of 150 pounds and that no more than 10 percent of the mixture, by weight, consists of fragments weighing 2 pounds or less each. Specific gravity of the rock shall be a minimum of 2.50. The inclusion of more than trace 1% quantities of dirt, sand, clay, and rock fines will not be permitted. The rock shall be either crushed rock or angular quarried stone. No round or thin, flat stones will be permitted. Rock shall be in its angular state nearly rectangular in cross-section as practible.

D. Refer to Section 31 30 00, "Sediment and Erosion Control Measures" for filter fabric requirements.

2.8 HEAVY RIP RAP

A. Shall conform to Maine DOT 703.28 and as follows

1. Stones shall consist of sound, durable rock, resistant to the action of air and water. Either field stone or rough, unhewn quarry stone may be used. The exposed stones shall be angular. Round or thin, flat stones will not be permitted. Stones shall have a minimum weight of 500 pounds each and at least 50% of the stones, by volume, shall exceed 1,000 pounds.
2. Filter fabric and bedding shall conform as indicated or as described for regular rip rap included in this specification section.

2.9 FLOWABLE FILL

A. Description: This section specifies the requirements for flowable fill used for trenches, support for pipe structures, culverts, utility cuts and other works where cavities exist and where firm support is needed for pavements and structural elements. Flowable fill may also be used to fill abandoned water and sewer lines, abandoned fuel tanks, and where any granular compacted fill is needed as is approved by the Engineer or where otherwise shown on the plans or as specified.

B. Consisting of the placement of a flowable material consisting of portland cement (Type I, II, or III ASTM C150) , fly ash (ASTM C618) and/or sand with an expected 28 day unconfined compressive strength of more than 50 pounds per square inch but less than 100 pounds per square inch. Fine aggregate shall be natural sand or sand manufactured from stone, gravel or air-cooled blast furnace slag. The mixture shall consist of: 50 lbs/CY Cement; 250 lbs/CY Fly Ash; 2,910 lbs/CY sand; and 500 lbs/CY water. The sand shall be fine enough to stay in suspension in the mixture to ensure proper flow. These mixtures of materials are expected to yield approximately one cubic yard of material of a flowable consistency. Small adjustments in the amounts of the materials in a mix may be required to achieve the final product. No additional compensation for a change in the material blends shall be allowed. The Contractor shall make one or more one cubic meter (cubic yard) trial batches at

different water contents to ensure a flowable material. The mixture is too dry when cracks develop in the fixture as it flows into place.

C. Adjustments of the proportions shall be based on maintaining the total absolute volume. In order to expedite the settlement of a mixture without entrained air, it may be necessary for bleed water to appear on the surface immediately after the material is struck off. A delay in bleeding indicates there are too many fines in the mixture. The fly ash quantity may be reduced in increments of 50 pounds until the mixture is bleeding freely. Approximately 60 pounds of sand shall be added to replace each 50 pounds increment of fly ash to maintain the original yield.

D. Other mixes may be submitted to the Architect/ Engineer for approval. The Contractor shall submit the mix design and test data from an independent test lab 30 days prior to the intended usage for approval. All alternate mixes shall have an unconfined compressive strength between 50 and 200 pounds per square inch at 28 days when tested in accordance with ASTM D 4832. The long term 12 month unconfined compressive strength shall be less than 100 pounds per square inch.

E. The final mix shall have the required strength, fill the voids of the intended usage and set up within 12 hours. The proportioning, yield, consistency, workability, compressive strength and all other requirements are the sole responsibility of the Contractor.

PART 3 EXECUTION

3.1 PROTECTION

A. Shoring and Sheeting: Provide shoring bracing, underpinning and sheeting where indicated or where required to perform work. In addition to Section XXIII A and B of COE EM-385-1-1, include provisions in the shoring and sheeting plan that will accomplish the following:

1. Prevent undermining of pavements, foundations and slabs.
2. Prevent slippage or movement in banks or slopes adjacent to the excavation.
3. When used, allow for the abandonment of shoring and sheeting materials in place in critical areas as the work is completed. In these areas, backfill the excavation to within 3 feet of the finished grade and remove the remaining exposed portion of the shoring before completing the backfill.

B. Dewatering: Plan for and provide the structures, equipment, and construction for the collection and disposal of surface and subsurface water encountered in the course of construction.

C. Water Removal: Remove water by pumping or other methods to prevent the softening of surfaces exposed by excavation, prevent hydrostatic uplift, and provide a stable trench condition for installation of the utility. Use screens and gravel packs or other filtering systems on the dewatering devices to prevent the removal of fines from the soil.

D. Operation and Performance: Operate the dewatering system continuously 24 hours a day, 7 days per week until construction work below existing water levels is complete. Measure and record the performance of the dewatering system at the same time each day with observation wells and piezometers installed in conjunction with the dewatering system.

After placement of the pipe or conduit and the initial backfill, the water level may be allowed to rise but at no time allow it to rise higher than one foot below the prevailing level of excavation or backfill. Have a back-up pump and system available for immediate use.

1. Structures and Surfaces: Protect newly backfilled areas and adjacent structures, slopes, or grades from traffic, erosion settlement, or any other damage. Repair and reestablish damaged or eroded grades and slopes and restore surface construction prior to acceptance. Protect existing streams, ditches, and storm drain inlets from water-borne soil by means of straw bale dike as indicated on the contract drawings and as required for good construction practices.

3.2 SURFACE PREPARATION

A. Stockpiling Loam: Strip suitable soil from the site where excavation or grading is indicated and stockpile separately from other excavated material. Material unsuitable for use as loam shall be stockpiled and used for backfilling. Locate loam so that the material can be used readily for the finished grading. Where sufficient existing loam conforming to the material requirements is not available on site, provide borrow materials suitable for use as loam. Protect loam and keep in segregated piles until needed.

B. Cutting Pavement and Curbs: Saw cut with neat, parallel, straight lines one foot wider than trench width on each side of trenches and one foot beyond each edge of pits. When the saw cut is within three (3) feet of an existing joint, remove pavement to the existing joint.

3.3 GENERAL EXCAVATION AND TRENCHING

A. Keep excavations free from water while construction is in progress. Notify the Architect immediately in writing if it becomes necessary to remove rock or hard, unstable, or otherwise unsatisfactory material to a depth greater than indicated. Make trench sides as nearly vertical as practicable except where sloping of sides is allowed. Sides of trenches shall not be sloped from the bottom of the trench up to the elevation of the top of the pipe, conduit, or duct. Excavate ledge rock, boulders, and other unyielding material to an overdepth at least 6 inches below the bottom of the pipe, conduit, or duct and appurtenances unless otherwise indicated or specified. Overexcavate soft, weak, or wet excavations. Use bedding material placed in 6-inch-maximum layers to refill overdepths to the proper grade. At the Contractor's option, the excavations may be cut to an overdepth of not less than 4 inches and refilled to required grade as specified. Grade bottom of trenches accurately to provide uniform bearing and support for each section of pipe, conduit, duct, structure on undisturbed soil, or bedding material as indicated or specified at every point along its entire length except for portions where it is necessary to excavate for bell holes and for making proper joints. Dig bell holes and depressions for joints after trench has been graded. Dimension of bell holes shall be as required for properly making the particular type of joint to ensure that the bell does not bear on the bottom of the excavation. Trench dimensions shall be as indicated or as required to properly perform the work.

B. Shoring and Sheeting: Shore and sheet excavations as described in the plan submitted with various member sizes arranged to prevent injury to persons and damage to structures. Arrange shoring and sheeting to preclude injurious caving during removal.

Obtain approval from the Architect prior to removing shoring, sheeting, or bracing in excavations adjacent to on-grade slabs, foundations, or other structural elements.

3.4 BEDDING

A. Of materials and depths as indicated or specified for utility lines and utility line structures. Place bedding in 6-inch- maximum loose lifts. Provide uniform and continuous support for each section of structure except at bell holes or depressions necessary for making proper joints.

B. Concrete Cradles: Specified in lieu of other types of bedding for a particular type of pipe material, shall be as specified.

3.5 BURIED WARNING AND IDENTIFICATION TAPE

A. Install tape in accordance with manufacturer's recommendations except as modified herein. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.6 BACKFILLING

A. Construct backfill in two operations (initial and final) as indicated and specified in this section. Place initial backfill in 6-inch-maximum loose lifts to one foot above pipe, conduit, or duct unless otherwise specified. Ensure that initially placed material is tamped firmly under pipe haunches. Bring up evenly on each side and along the full length of the pipe, conduit, or duct structure. Ensure that no damage is done to the utility or its protective coating. Place the remainder of the backfill (final backfill) in 9-inch-maximum loose lifts unless otherwise specified. Compact each loose lift as specified in the paragraph entitled "General Compaction" before placing the next lift. Do not backfill in freezing weather or where the material in the trench is already frozen or is muddy, except as authorized. Provide a minimum cover from final grade as indicated. Where settlements greater than the tolerance allowed herein for grading occur in trenches and pits due to improper compaction, excavate to the depth necessary to rectify the problem, then backfill and compact the excavation as specified herein and restore the surface to the required elevation. Coordinate backfilling with testing of utilities. Examples of testing that shall be complete before final backfilling are as follows: water distribution, storm drainage, sanitary sewer, gas distribution systems. Provide buried warning and identification tape installed in accordance with the manufacturer's recommendation.

3.7 COMPACTION

A. Use hand-operated, plate-type, vibratory, or other suitable hand tampers in areas not accessible to larger rollers or compactors. Avoid damaging pipes and protective pipe coatings. Compact material in accordance with the following unless otherwise specified. If necessary, alter, change, or modify selected equipment or compaction methods to meet specified compaction requirements.

B. Compaction of Material in Subcuts or Overexcavations: In rock, compact to 95 percent of ASTM D1557 maximum density. In soft, weak, or wet soils, tamp refill material to consolidate to density of adjacent material in trench wall. In stable soils, compact to 90 percent of ASTM D1557 maximum density.

C. Compaction of Pipe and Conduit Bedding: In rock, compact to 95 percent and in soil, compact to 90 percent of ASTM D1557 maximum density.

D. Compaction of Backfill: Compact initial backfill material surrounding pipes, cables, conduits, or ducts, to 90 percent of ASTM D1557 maximum density except where bedding and backfill are the same material. Where bedding and backfill are the same material, compact initial backfill to the density of the bedding. Under areas to be seeded or sodded, compact succeeding layers of final backfill to 85 percent of ASTM D1557 maximum density. For utilities under highway right-of-way, structures and pavements compact succeeding layers of final backfill as specified under paragraph entitled "Special Earthwork Installation Requirements" or compact succeeding layers of final backfill as specified under section 31 20 00 “Earthwork for Structures and Pavements", whichever is the more stringent.

E. Flowable Fill Placement: Sufficient mixing capacity and delivery equipment shall be provided for the material to be placed without interruption as much as practical. Flowable fill shall be produced and delivered using standard concrete construction equipment and practices. The mixture shall be discharged within 2.5 hours after the water is added. Placing flowable fill shall be by chute, pumping, or other method approved by the Engineer into the space of the plan intended usage. The fill material shall be brought up uniformly to the fill line shown on the plans or as directed by the Architect/Engineer. Placing of the other fill material over low strength mortar backfill material may commence as soon as the surface water is gone or as directed by the Architect/Engineer. The Architect/Engineer reserves the right to reject the mix if a flowable mixture is not produced.

1. Before placing the low strength mortar backfill as backfill for conduit or sleeves, the Contractor shall secure the conduit or sleeve to prevent it from floating during placement of the flowable material.
2. Flowable fill limitation of operation: No flowable fill shall be placed on frozen ground. Mixing and placing of the material is acceptable in freezing temperatures. At the time of placement the flowable fill shall have a temperature of at least 40 degrees F. When flowable fill is placed in freezing temperatures, the material should be covered with blankets overnight. When paving over flowable fill in cold weather, any frozen material on the surface can be scraped off and removed prior to paving.
3. The flowable fill shall be left undisturbed until the material obtains sufficient strength. Sufficient strength for paving is achieved when the flowable fill can support the weight of foot traffic without apparent deformation. Sufficient strength for supporting vehicular traffic is 2.5 tons per square foot as measured by a pocket penetrometer.

3.8 SPECIAL EARTHWORK INSTALLATION REQUIREMENTS

A. Manholes and Other Appurtenances: Provide at least 12 inches clear from outer surfaces to the embankment or shoring. Remove rock as specified herein. Remove unstable soil that is incapable of supporting the structure to an overdepth of one foot and refill with coarse aggregate to the proper elevation. Stabilize soft, weak, or wet excavations. Refill overdepths with coarse aggregate to the required grade and compact to 95% unless indicated otherwise on drawings.

B. Compaction for Structures and Pavements: Place final backfill in 6-inch-maximum loose lifts. If a vibratory roller is used for compaction of final backfill, the lift thickness can be

increased to 9 inches. Compact all backfill surrounding pipes, ducts, conduits, and other structures to 95 percent of ASTM D1557 maximum density and compact the top 12 inches of subgrade to 95 percent of ASTM D1557 maximum density. Backfill to permit the rolling and compacting of the completed excavation with the adjoining material, providing the specified density necessary to enable paving of the area immediately after backfilling has been completed.

3.9 RIP-RAP CONSTRUCTION

A. Construct rip-rap as indicated and as follows.

1. Preparation: Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 0.l foot.

B. Bedding Placement: Spread filter fabric and bedding material uniformly to a thickness of at least 3 inches on prepared subgrade or as indicated. Finish bedding to present even surface free from mounds and windows.

C. Stone Placement: Place rock for rip-rap on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.

3.10 FINISH OPERATIONS

A. Grading: Finish to grades indicated within one-tenth of a foot. Provide sod or loam in areas to be seeded or sodded as indicated and in accordance with requirements specified in Section 32 92 00, "Turf and Grasses." Grade areas to drain water away from structures and to provide suitable surfaces for mowing machines. Grade existing grades that are to remain but have been disturbed by the Contractor's operations.

B. Spreading Loam: Clear areas to receive loam for the finished surface of materials that would interfere with planting and maintenance operations. Scarify subgrade to a depth of 2 inches. Do not place loam when the subgrade is frozen, extremely wet or dry, or in other conditions detrimental to seeding, planting, or grading. Comply with the requirements of Section 32 92 00, "Turf and Grasses." Spread loam to a uniform depth of 6 inches over the designated areas.

C. Disposition of Surplus Material: Surplus or other soil material not required or suitable for filling, backfilling, or grading shall be removed from Owner's property unless otherwise noted or directed in writing. Comply with all environmental requirements.

D. Protection of Surfaces: Protect newly graded areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

E. Pavement Repair: Repair pavement, curbs, and gutters as indicated and as required. Do not repair pavement until trench or pit has been backfilled and compacted as specified herein. Provide a temporary road surface of gravel over backfilled portion until permanent pavement is repaired. Remove and dispose of temporary road surface material when

permanent pavement is placed. As a minimum, maintain one-way traffic on roads and streets crossed by trenches. Fully open roads and streets to traffic within 1 day.

3.11 FIELD QUALITY CONTROL

A. General Contractor to arrange for and Owner to pay for all soils and field testing. The General Contractor shall pay for any required retesting by the Architect and Owner.

B. Test sand, bedding, backfill, loam, coarse aggregate, granular fill for conformance to specified requirements. Test backfill to be used under roads and paved areas for conformance to special requirements. Test bedding and backfill for moisture-density relations in accordance with ASTM D698, ASTM D1557 as specified herein. Perform at least one of each of the required tests for each material provided. Perform sufficiently in advance of construction so as not to delay work. Provide additional tests as specified above for each change of source. Perform density and moisture tests in randomly selected locations and in accordance with required ASTM numbers as follows:

1. Bedding and Backfill in Trenches: One test per 50 linear feet in each lift.
2. Appurtenance Structures: One test per 100 square feet or fraction thereof in each lift.
3. Where ASTM D6938 is used to test field compaction densities, verify test results by performing at least one test per day using ASTM D1556 at a location already tested in accordance with ASTM D6938. Perform at least one additional test using ASTM D1556 for every ten tests performed with a nuclear device, at locations checked in accordance with ASTM D6938.

C. The contractor reserves the right to test the material for proper gradation in advance of the project's notice to proceed, however the owner reserves the right to request the material be retested once the materials has arrived on site, especially including but not limited to if one of the following has occurred; more than 3 months have passed since the initial material testing had been done, if the material arriving on site for placement appears to not meet spec, if the supplier stockpile has been reworked or if the stockpile supplier has changed, or if mixing of on-site stockpiles has occurred, or other similar occurrences which may affect the products integrity.

END OF SECTION 31 21 00

SECTION 31 23 19 - DEWATERING

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 construction dewatering.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation" for recording preexisting conditions and dewatering system progress.
2. Division 31 Section "Earth Moving" for excavating, backfilling, site grading, and for site utilities.
3. Division 31 Section “Erosion Control” for sediment and erosion controls measures/products.
4. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
5. Division 33 Section "Subdrainage" for permanent foundation wall, under floor, and footing drainage and site drainage.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Remove dewatering system when no longer required for construction.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and

results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is included elsewhere in the Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Photo Documentation: Digital photo documentation should be made. This includes pre-dewatering, during dewatering, and post-dewatering.

1.6 1.6 SUBMITTALS

A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, discharge splash pads, dirt-bags, control of sediment, including location of temporary settling ponds, and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written plan, prepared and stamped by a state licensed professional engineer registered in the state the dewatering operations will take place, for dewatering operations including control procedures to be adopted if dewatering problems arise.
3. Site photos of showing conditions before dewatering operations begin. Photos should include items and system parts identified in the dewatering plan and shall show any nearby waterways to be used as comparison should erosion and sediment control problems arise. Site photos shall be submitted before, during and upon the conclusion of dewatering operations. These photos should show discharge of water did not create on-site or off-site erosion and sediment control problems. Including the condition of any nearby waterways

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

Provide upstream surface water diversion berms and subsurface groundwater diversion underdrains.

2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls during dewatering operations.

G. Major problems or deficiencies may require construction operations to shut down until the situation has been corrected. If the architect or owner points out a problem or deficiency and the contractor has not made significant attempts to correct the situation, the owner reserves the right to shut down construction operations until the correction has been made and the contractor will not be compensated for lost time or money due to construction stoppage.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, dirt-bags, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Freezing/snow conditions: The contractor should take the proper precautions ensure that none of the dewatering system will be adversely impacted or compromised due to weather such as below freezing temperatures or accumulating snow. The contractor is responsible for removing ice or snow that impacts the dewatering process and their ability to safely discharge the water. This includes checking for snow/ice blockage downstream or off-site of the dewatering discharge point and remedying the situation to ensures the worker and public safety and health.

H. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations in a timely manner.

END OF SECTION 31 23 19

SECTION 31 30 00 - EROSION CONTROL

SEDIMENTATION AND EROSION CONTROL MEASURES

PART 1 GENERAL

2.1 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.

2.2 SUMMARY

A. This section includes the following:

1. Establishment and maintenance of temporary and permanent drainage areas.
2. Construction, stabilization and maintenance of temporary construction entrances.
3. Construction and maintenance of temporary and permanent outfalls, swales, waterways and embankments.
4. Temporary and permanent vegetative stabilization.
5. Establishment and maintenance of designated stockpile areas.
6. Construction and maintenance of silt fences, stone check dams and hay bale barriers.
7. All erosion and sediment control work required for the safe conduct of the work, whether or not specifically mentioned in these Specifications or indicated on the Drawings.

B. Related Sections include the following:

1. Division 32 Section "Turf and Grasses, Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
2. Division 31 Section "Site Clearing" for temporary measures required for site clearing.
3. Division 31 Section "Earth Moving for Pavements and Structures" for soil materials, excavating, backfilling, and site grading.
4. Division 31 Section "Earth Moving for Utilities" for soil materials, excavating, backfilling for utilities.

2.3 REFERENCES

A. Quality, grades of materials and installation procedure: In conformance with applicable code and standards including:

1. American Society for Testing and Materials (ASTM).
2. State of Maine, Department of Transportation, Standard Specifications (MDOT) 12/2002.
3. Maine Erosion and Sedimentation Control Handbook for Construction: Best Management Practices 3/2003.

B. Land, Air and Water Pollution: Comply with Pollution Control Standards for the State of Maine applicable to the work to ensure that no pollution is caused by work of this Contract.

C. Soil Erosion and Sediment Control: Implement soil erosion and sediment control in strict accordance with provisions of the Erosion and Sedimentation Control Handbook.

D. MDEP Stormwater Management Law Permit (Stormwater Permit): Implement soil erosion and sediment control in strict accordance with provisions of this permit.

2.4 DEFINITIONS

A. Sediment: Soil and other debris that have eroded and have been transported by runoff water or wind.

B. Dust: Earthy material and any substance reduced to fine powder.

C. Solid Waste: Rubbish, debris, garbage, and other discarded solid materials, except hazardous waste as defined in paragraph entitled "Hazardous Waste," resulting from industrial, commercial, and agricultural operations and from community activities.

D. Rubbish: Combustible and noncombustible wastes such as paper, boxes, glass, crockery, metal, lumber, cans, and bones.

E. Debris: Combustible and noncombustible wastes such as ashes and waste materials resulting from construction or maintenance and repair work, leaves, and tree trimmings.

F. Oily Waste: Petroleum products and bituminous materials.

2.5 SUBMITTALS

A. Factory Test Reports and data sheets

1. Erosion Control Mesh.
2. Geotextile fabric(s).
3. Silt Fence.
4. Erosion Control Mix

2.6 ENVIRONMENTAL PROTECTION REQUIREMENTS

A. Provide and maintain, during the life of the contract, environmental protection as defined. Plan for and provide environmental protective measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project. Comply with Federal, State, and local regulations pertaining to the environment, including but not limited to water, air, light, and noise pollution.

B. Environmental Protection Plan: Five days after the award of contract, the Contractor shall meet with the contracting Officer to discuss the proposed environmental protection plan and to develop mutual understanding relative to the details of environmental protection, including measures for protecting natural resources, required reports, and other measures to be taken.

C. Environmental Planning: Fourteen days after the meeting, the Contractor shall submit to the Architect/Engineer the proposed environmental plan for further discussion, review, and approval.

D. Commencement of the Work: As directed by the Contracting Officer, following approval.

PART 2 PRODUCTS

3.1 MATERIALS

A. All Products: As specified by Erosion and Sedimentation Control Handbook.

B. All Fill Materials: In accordance with requirements of Section 31 20 00, “Earth Moving for Structures and Pavements”.

C. Temporary Vegetative Stabilization: Temporary Seeding for graded or cleared areas, which are subject to erosion for a period of 14 days or more. Vegetation in accordance with Handbook.

D. Permanent Vegetative Stabilization: Seeding for graded or cleared areas subject to erosion where a permanent, long-lived vegetation cover is needed. Vegetation in accordance with Handbook.

E. Riprap Waterways and Outfalls:

1. Riprap: Sizes indicated.
2. Drainage Fabric:

a. Outfalls: UV stabilized geotextile, possessing the following characteristics, for separation and erosion control:

Mechanical Properties	Test method	Unit	Minimum Average Roll Value	
			MD	CD
Wide Width Tensile Strength	ASTM d4595	kN/m (lbs/in)	40.3 (230)	39.4 (225)
Grab Tensile Strength	ASTM D 4632	N (lbs)	1780 (400)	1491 (335)
Grab Tensile Elongation	ASTM D 4632	%	20	15
Trapezoid Tear Strength	ASTM D 4533	N (lbs)	645 (145)	556 (125)
CBR Puncture Strength	ASTM D 6241	N (lbs)	5563 (1250)	
Apparent Opening Size (AOS) *	ASTM D 4751	mm (U.S. Sieve)	0.60 (30)	
Permittivity	ASTM D 4491	sec-1	1.5	
Flow Rate	ASTM D 4491	l/min/m2 (gal/min/ft2)	4685 (115)	
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	90	

* ASTM D 4751: AOS IS A MAXIMUM OPENING DIAMETER VALUE

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	g/m2 (oz/yd2)	271 (8.0)
Thickness	ASTM D 5199	mm (mils)	0.9 (35)
Roll Dimensions (width x length)	--	m (ft)	3.8 x 91 (12.5 x 300)
Roll Area	--	m2 (yd2)	348 (417)
Estimated Roll Weight	--	kg (lb)	100 (221)

a. Acceptable products: Mirafi FW300 or approved equal.

b. Waterways: needle-punched nonwoven geotextile composed of polypropylene fibers, possessing the following characteristics, for separation and erosion control:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D 4632	N (lbs)	534 (120)	534 (120)
Grab Tensile Elongation	ASTM D 4632	%	50	50
Trapezoid Tear Strength	ASTM D 4533	N (lbs)	223 (50)	223 (50)
CBR Puncture Strength	ASTM D 6241	N (lbs)	1335 (300)	
Apparent Opening Size (AOS) *	ASTM D 4751	mm (U.S. Sieve)	0.212 (70)	
Permittivity	ASTM D 4491	sec-1	1.7	
Flow Rate	ASTM D 4491	l/min/m2 (gal/min/ft2)	5500 (135)	
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70	

* ASTM D 4751: AOS IS A MAXIMUM OPENING DIAMETER VALUE

Physical Properties	Test Method	Unit	Typical Value

Weight	ASTM D 5261	g/m2 (oz/yd2)	163 (4.8)	
Thickness	ASTM D 5199	mm (mils)	1.0 (40)	
Roll Dimensions (width x length)	--	m (ft)	3.8 x 110 (12.5 x 360)	4.5 x 110 (15 x 360)
Roll Area	--	m2 (yd2)	418 (500)	502 (600)
Estimated Roll Weight	--	kg (lb)	74 (164)	89 (197)

a. Acceptable products: Mirafi 140N or approved equal.

B. Grass Waterways & Embankments:

1. Vegetation: In accordance with Handbook; Section 32 92 00, “Turf and Grasses”.
2. Erosion Control Mat: for slopes less steep than 2:1, short-term double net erosion control blanket, machine-produced mat of 100% agricultural straw with a functional longevity of up to 12 months.

Property	Test Method	Typical
Thickness	ASTM D6525	0.36 in (9.14 mm)
Resiliency	ECTC Guidelines	80.5%
Water Absorbency	ASTM D1117	514%
Mass/Unit Area	ASTM 6475	10.52 oz/yd2 (357.7 g/m2)
Swell	ECTC Guidelines	15%
Smolder Resistance	ECTC Guidelines	Yes
Stiffness	ASTM D1388	6.06 oz-in
Light Penetration	ECTC Guidelines	9.8%
Tensile Strength –MD	ASTM D6818	169.2 lbs/ft (2.51 kN/m)
Elongation – MD	ASTM D6818	17.2%
Tensile Strength – TD	ASTM D6818	164.4 lbs/ft (2.44 kN/m)
Elongation – TD	ASTM D6818	33.1%

3. Acceptable products: North American Green S150 or approved equal.
4. Erosion Control Mat: for slopes 2:1 or steeper, extended-term double net erosion control blanket, machine-produced mat of 70% agricultural straw and 30% coconut fiber with a functional longevity of up to 24 months.

Property	Test Method	Typical
Thickness	ASTM D6525	0.39 in (9.91 mm)
Resiliency	ECTC Guidelines	75%
Water Absorbency	ASTM D1117	285%
Mass/Unit Area	ASTM 6475	11.44 oz/yd2 (388 g/m2)
Swell	ECTC Guidelines	30%
Smolder Resistance	ECTC Guidelines	Yes
Stiffness	ASTM D1388	1.11 oz-in

Light Penetration	ECTC Guidelines	8.7%
Tensile Strength –MD	ASTM D6818	146.6 lbs/ft (2.17 kN/m)
Elongation – MD	ASTM D6818	26.9%
Tensile Strength – TD	ASTM D6818	147.6 lbs/fit (2.19 kN/m)
Elongation – TD	ASTM D6818	25.2%

5. Acceptable products: North American Green SC150 or approved equal.

C. Temporary Construction Entrances:

1. Coarse Aggregate in accordance with requirements of Section 31 20 00, “Earth Moving for Structures and Pavements”.
2. Culvert: RCP.
3. Fabric: woven polypropylene separation geotextile, possessing the following characteristics:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D 4632	N (lbs)	1402 (315)	1402 (315)
Grab Tensile Elongation	ASTM D 4632	%	12	
Trapezoid Tear Strength	ASTM D 4533	N (lbs)	503 (113)	503 (113)
CBR Puncture Strength	ASTM D 6241	N (lbs)	4005 (900)	
Apparent Opening Size (AOS) *	ASTM D 4751	mm (U.S. Sieve)	0.43 (40)	
Permittivity	ASTM D 4491	sec-1	0.05	
Flow Rate	ASTM D 4491	l/min/m2 (gal/min/ft2)	163 (4.0)	
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70	

4. * ASTM D 4751, AOS is a Maximum Opening Diameter Value

Physical Properties	Test Method	Unit	Typical Value	
Weight	ASTM D 5261	g/m2 (oz/yd2)	203 (6.0)	
Thickness	ASTM D 5199	mm (mils)	0.6 (25)	
Roll Dimensions	--	m (ft)	3.8 x 110	5.3 x 78.7

(width x length)			(12.5 x 360)	(17.5 x 258)
Roll Area	--	m2 (yd2)	418 (500)	418 (500)
Estimated Roll Weight	--	kg (lb)	109 (240)	109 (240)

5. Acceptable products:
    a. Mirafi 600X, HP570
    b. Propex Petromax 4598
    c. or approved similar.

D. Hay Bale Barriers, Dams:

1. Barriers: Wire or nylon bound straw or hay bales.
2. Stakes: Steel rebar or 2 x 2 inch wood stakes.

E. Silt Fence:

1. Posts:
    a. Wood: Minimum 2 inch hardwood stakes.
    b. Steel: Type T or Type U.
2. Fabric: High strength polypropylene netting treated to ensure protection against sunlight degradation:

Mechanical Properties	Test Method	Unit	Silt Fence Property		Typical Values (English)
			MD	CD	
Grab Tensile Strength	ASTM D 4632	kN	0.55	0.55	125 X125 lbs
Grab Tensile Elongation	ASTM D 4632	%	15	15	15 %
Puncture Strength	ASTM D 4833	kN	266		60 lbs.
Apparent Opening Size (AOS) *	ASTM D 4751	mm	0.60		20 sieve
Permittivity	ASTM D 4491	sec-1	0.10		0.10 sec-1
Flow Rate	ASTM D 4491	l/min/m2	405		8 gal/min/ft2

UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70	70 %

(a) * ASTM D 4751, AOS is a Maximum Opening Diameter Value

3. Mirafi Silt Fence.
    a. Propex Geotex woven Silt Fence
    b. Carthage Mills FX-11 Silt Fence
    c. Approved equal.

F. Riprap Embankments:

1. Riprap: Sizes indicated.
2. Drainage Fabric: Mirafi 180N or approved equal.

G. Stone Check Dams:

1. Stone: Sizes indicated.
2. Fabric: woven polypropylene separation geotextile, possessing the following characteristics:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D 4632	N (lbs)	890 (200)	890 (200)
Grab Tensile Elongation	ASTM D 4632	%	15	10
Trapezoid Tear Strength	ASTM D 4533	N (lbs)	334 (75)	334 (75)
CBR Puncture Strength	ASTM D 6241	N (lbs)	3115 (700)	
Apparent Opening Size (AOS) *	ASTM D 4751	mm (U.S. Sieve)	0.43 (40)	
Permittivity	ASTM D 4491	sec-1	0.05	
Flow Rate	ASTM D 4491	l/min/m2 (gal/min/ft2)	204 (5.0)	
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70	

(a) * ASTM D 4751, AOS is a Maximum Opening Diameter Value

Physical Properties	Test Method	Unit	Typical Value	
Weight	ASTM D 5261	g/m2 (oz/yd2)	136 (4.0)	
Thickness	ASTM D 5199	mm (mils)	0.5 (20)	
Roll Dimensions (width x length)	--	m (ft)	3.8 x 132 (12.5 x 432)	5.3 x 94.2 (17.5 x 309)
Roll Area	--	m2 (yd2)	502 (600)	502 (600)
Estimated Roll Weight	--	kg (lb)	95 (210)	95 (210)

3. Acceptable products: Mirafi 500X or approved equal.

H. Erosion Control Mix Berms

1. Erosion control mix can be manufactured on or off the project site. It must consist primarily of organic material, separated at the point of generation, and may include: shredded bark, stump grindings, or acceptable manufactured products. Wood and bark chips, ground construction debris or reprocessed wood products will not be acceptable as the organic component of the mix.
2. Composition. Erosion control mix shall contain a well-graded mixture of particle sizes and may contain rocks less than 4” in diameter. Erosion control mix must be free of refuse, physical contaminants, and material toxic to plant growth. The mix composition shall meet the following standards:
    a. The organic matter content shall be between 50 and 100%, dry weight basis.
    b. Particle size by weight shall be 100 % passing a 6“screen and a minimum of 70 %, maximum of 85%, passing a 0.75” screen.
    c. The organic portion needs to be fibrous and elongated.
    d. Large portions of silts, clays or fine sands are not acceptable in the mix.
    e. Soluble salts content shall be < 4.0 mm/cm.
    f. The pH should fall between 5.0 and 8.0.
3. Installation
    a. The barrier must be placed along a relatively level contour. It may be necessary to cut tall grasses or woody vegetation to avoid creating voids and bridges that would enable fines to wash under the barrier through the grass blades or plant stems.
    b. On slopes less than 5 % or at the bottom of steeper slopes (<2:1) up to 20 feet long, the barrier must be a minimum of 12” high, as measured on the uphill side of the barrier, and a minimum of two feet wide. On longer or steeper slopes, the barrier should be wider to accommodate the additional runoff.

c. Frozen ground, outcrops of bedrock and very rooted forested areas are locations where berms of erosion control mix are most practical and effective.

d. Other BMPs should be used at low points of concentrated runoff, below culvert outlet aprons, around catch basins and closed storm systems, and at the bottom of steep perimeter slopes that are more than 50 feet from top to bottom (i.e., a large up gradient contributing watershed).

I. Sediment Filtration Bag (Dirt Bag)

1. Sediment filtration bags shall be a commercially manufactured product consisting of a bag or tube made from geotextile material used for the purpose of filtering suspended sediment from water, typically used in dewatering operations where the product is attached to the end of the outlet pipe forcing the water through the geotextile material.
2. Size: as indicated or sized to match the desired use
3. Fabric: engineered woven textile with high tenacity polypropylene. The material shall be woven into a stable network such that it retains its relative position. The geotextile, shall be inert to biological degradation and resistant to naturally encountered chemicals possessing the following characteristics:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Wide Width Tensile Strength	ASTM D 4595	kN/m (lbs/in)	78.8 (450)	109.4 (625)
Wide Width Tensile Elongation	ASTM D 4595	%	20 (max.)	20 (max.)
Factory Seam Strength	ASTM D 4884	kN/m (lbs/in)	70 (400)	
CBR Puncture Strength	ASTM D 6241	N (lbs)	8900 (2000)	
Apparent Opening Size (AOS) *	ASTM D 4751	mm (U.S. Sieve)	0.43 (40)	
Water Flow Rate	ASTM D 4491	l/min/m2 (gal/min/ft2)	813 (20)	
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	80	

(a) * ASTM D 4751, AOS is a Maximum Opening Diameter Value

Filtration Properties	Test Method	Unit	Typical Value
Pore Size Distribution (050)	ASTM D 6767	micron	80
Pore Size Distribution (090	ASTM D 6767	micron	195
Physical Properties	Test Method	Unit	Typical Value
Mass/Unit Area	ASTM D 5261	g/m2 (oz/yd2)	585 (17.3)
Thickness	ASTM D 5199	mm (mils)	70 (1.8)

4. Acceptable products: Tencate Geotube GT500 or approved equal.

PART 3 EXECUTION

6.1 PROTECTION OF NATURAL RESOURCES

A. Preserve the natural resources within the project boundaries and outside the limits of permanent work. Restore to an equivalent or improved condition upon completion of work. Confine construction activities to within the limits of the work indicated or specified.

B. Land Resources:

1. Protection of Vegetation: Except in areas to be cleared, do not remove, cut, deface, injure, or destroy trees or shrubs without the Architect/Engineer permission. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorages unless authorized by the Architect/Engineer. Where such use of attach ropes, cables, or guys is authorized, the Contractor shall be responsible for any resultant damage. Protect existing trees, which are to remain, and which may be injured, bruised, defaced, or otherwise damaged by construction operations. Remove displaced rocks from uncleared areas. By approved excavation, remove trees with 30 percent or more of their root systems destroyed.

C. Grading

1. Limit initial grading to that required to install required sediment and erosion controls.
2. Extent: Remain just ahead of planned new construction.
3. Plan to control runoff and contain erosion.
4. Do not place fill before existing vegetation has been removed.
5. Do not impair existing surface drainage, create potential hazards, cause hazardous erosion, or cause sediment to collect in drainage systems on adjacent properties, alleys, streets or highways by grading operations.
6. Riprap Outfalls, Outlets, and Waterways: Construct in accordance with details. Embed riprap in approved fabric.

7. Grass Waterways: Construct in accordance with details for specific profile. Pin fabric mesh to subgrade with U or T pins in accordance with fabric manufacturer's recommendations.
8. Hay Bales:
    a. Place at areas indicated in rows with ends tightly butted.
    b. Embed each bale a minimum of 4 inches into soil.
    c. Securely anchor in place with two stakes driven 1-1/2 to 2 feet into ground.
9. Silt Fence:
    a. Establish silt fence at areas indicated and as required for control.
    b. Space posts as required to adequately support wire and cloth against flow and at a maximum of 6 feet oc. Embed posts into ground a minimum of 18 inches.
    c. Fasten woven wire fence securely to posts with wire ties or staples.
    d. Fasten filter cloth to wire mesh at top and mid-section with ties spaced every 24 inches; overlap edges minimum 6 inches and fold.
    e. Embed filter cloth minimum 8 inches into ground.

D. Borrow Pit Areas: Manage and control borrow pit areas to prevent sediment from entering nearby streams or lakes. Restore areas, including those outside the borrow pit, disturbed by borrow and haul operations. Restoration includes grading, replacement of topsoil, and establishment of a permanent vegetative cover. Uniformly grade side slopes of borrow pit to not more than a slope of 1 part vertical to 2 parts horizontal. Uniformly grade the bottom of the borrow pits to provide a flat bottom and drain by outfall ditches or other suitable means. Stockpile topsoil removed during the borrow pit operation, and use as part of restoring the borrow pit area.

E. Protection of Erodible Soils: Immediately finish the earthwork brought to a final grade, as indicated or specified. Immediately protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils.

F. Mechanical Retardation and Control to Runoff: Mechanically retard and control the rate of runoff from the construction site. This includes construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses.

G. Vegetation and Mulch: Provide temporary protection on sides and back slopes as soon as rough grading is completed or sufficient soil is exposed to require erosion protection. Protect slopes by accelerated growth of permanent vegetation, temporary vegetation, mulching, or netting. Stabilize slopes by hydroseeding, anchoring mulch in place, covering with anchored netting, sodding, or such combination of these and other methods necessary for effective erosion control.

1. Seeding: Provide new seeding where ground is disturbed. Include topsoil or nutriment during the seeding operation necessary to reestablish a suitable stand of

grass. The seeding operation shall be as specified in Section 32 92 00, “Turf and Grasses”.

H. Stabilization

1. Stabilize all cleared or graded areas. Stabilize with temporary or permanent vegetation, mulch, or paving as indicated on Drawings within 15 days of obtaining final grade or 30 days after obtaining temporary grade.
2. For vegetating critical areas where erosion is imminent, place and repeatedly replace adequate mulch, fertilizer, and seed until a vigorous and adequate growth of turf has been established over greater than 80 percent of the area.

I. Replacement: Remove trees and other landscape features scarred or damaged by equipment operations, and replace with equivalent, undamaged trees and landscape features. Obtain Architect/Engineer's approval before replacement.

J. Temporary Construction: Remove traces of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other signs of construction. Grade temporary roads, parking areas, and similar temporarily used areas to conform with surrounding contours.

K. Burnoff: Burnoff of the ground cover is not permitted.

L. Dust Control: Keep dust down at all times, including during nonworking periods. Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and other areas disturbed by operations. Dry power brooming will not be permitted. Instead, use vacuuming, wet mopping, wet sweeping, or wet power brooming. Air blowing will be permitted only for cleaning nonparticulate debris such as steel reinforcing bars. Only wet cutting will be permitted for cutting concrete blocks, concrete, and bituminous concrete. Do not unnecessarily shaking bags of cement, concrete mortar, or plaster.

6.2 MAINTENANCE

A. Vegetative Stabilization: Irrigate to prevent loss of stand of protective vegetation. Regularly inspect and overseed as necessary. Immediately reestablish damaged stands.

B. Hay Bales: Inspect weekly and after every rain; adjust as needed, removing material when bulges develop.

C. Silt Fence: Inspect weekly and after every rain; adjust as needed, removing material when bulges develop.

D. Construction Entrances: Inspect and repair after every rain. Maintain in a condition to prevent tracking or flowing of sediment onto public right-of-ways. Dress with stone as required.

E. Swales, Outfalls: Inspect regularly and after every rain; maintain clear of obstructions and excessive sediment.

F. Dikes, Embankments, Landgrading: Inspect weekly and after every rain. Repair as required to maintain integrity or drainage areas.

6.3 REPAIRS, REMOVALS

A. At completion of work, remove designated temporary controls and revise all permanent sediment controls to original condition.

B. Repair all damages caused by soil erosion and construction activity at or before the end of every working day.

C. Remove sediment fence when all disturbed areas have been stabilized and a catch of grass greater than 80 percent has been established.

END OF SECTION 31 30 00

SECTION 32 12 16 - ASPHALT PAVEMENT

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.

1.2 SUMMARY

A. Section includes work pertaining to new and recycled bituminous concrete pavings, including sidewalks, gutters, and HMA parking and maneuver area.

B. Related Sections:

1. Division 31 Section "Site Clearing" for demolition, removal, and recycling of existing asphalt pavements.
2. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
3. Division 31 Section "Erosion Control" for geotextile materials
4. Division 32 Sections for other paving installed.
5. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.
6. A Geotechnical Report has been provided elsewhere in the project manual, please review for additional information and limitations.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

a. AASHTO M156 1989 (Rev. 1993) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

b. AASHTO T84 1995 Standard Specification for Specific Gravity and Absorption of Fine Aggregate

c. AASHTO T176 1997 (Rev. 1999) Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

d. AASHTO T304 1996 Standard Method of Test for Uncompacted Void Content of Fine Aggregate

e. AASHTO TP-4 1999 Standard Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor

f. AASHTO TP-58 1999 Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

g. AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)

h. ANSI A10.17 2006 Safe Operating Practice for Asphalt Pavement Construction

i. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

j. ASTM C128 2007 (Rev. A) Specific Gravity and Absorption of Fine Aggregate

k. ASTM C142 1997 (Rev. 2004) Test Method for Clay Lumps and Friable Particles in Aggregates

l. ASTM C295 2008 Petrographic Examination of Aggregate for Concrete

m. ASTM D979 2006 (Rev. 1) Sampling Bituminous Paving Mixtures

n. ASTM D2172 2005 Quantitative Extraction of Bitumen from Bituminous Paving Mixtures

o. ASTM D4791 2005 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

p. ASTM D5821 2001 (Rev. 2006) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

q. STATE OF MAINE DEPARTMENT OF TRANSPORTATION (MDOT) STANDARD SPECIFICATIONS, 12/2002

r. MDOT 401 Hot Mix Asphalt Pavement

1.4 GENERAL REQUIREMENTS (MDOT 401.01)

A. The Contractor shall furnish and place one or more courses of Hot Mix Asphalt Pavement (HMA) on an approved base in accordance with the contract documents and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans.

1.5 SUBMITTALS

A. Mix Designs (Contractor and Job) (produced within the current paving season)

1. The Contractor shall submit for approval a Job Mix Formula (JMF) to the Owner's independent testing agency for each mixture to be supplied. The Owner's independent testing agency shall then have 15 calendar days in which to process a new design prior to approval. The JMF shall establish a single percentage of aggregate passing each required sieve size within the limits shown in Table 2, and shall not cross the restricted zone. The general composition limits given in Table 2 indicate the control points of mixtures permissible under this specification. The JMF shall state the source, gradation, and percentage to be used of each portion of the aggregate, and mineral filler if required. It shall also state the proposed Performance Graded Asphalt Binder (PGAB) content, the name and location of the refiner and the supplier for the source of PGAB submitted for approval, and the type of PGAB modification if applicable.
2. At the time of JMF submittal, the Contractor shall identify and make available the stockpiles of all proposed aggregates at the plant site. The Owner's independent testing agency shall obtain samples for laboratory testing. The Contractor shall also

make available to the Owner's independent testing agency the PGAB proposed for use in the mix in sufficient quantity to test the properties of the asphalt and to produce samples for testing of the mixture. The Contractor shall submit a new JMF for approval each time a change in aggregate source or a change in PGAB is proposed. The same approval process shall be followed. The cold feed percentage of any aggregate may be changed up to 10 percent of the amount listed on the JMF, however no aggregate listed on the JMF shall be eliminated. The target percentage of RAP shall be the percentage listed on the JMF.

B. Certificates of Compliance

1. Submit a certificate of compliance for each shipment of hot mix asphalt material used in the mix.
2. Submit a certificate of compliance for hot mix asphalt curbing material.

C. Drawings

1. Provide details of all proposed curbing sections including length, radius, height, and width.

1.6 DELIVERY AND STORAGE

A. Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.7 TRAFFIC CONTROL

A. Vehicular traffic, including heavy equipment, shall not be permitted on the pavement until the surface temperature has cooled to at least 120-degrees F. Surface temperature shall be measured by approved surface thermometers or other satisfactory methods.

1.8 OPERATION SAFETY AND HEALTH GUIDELINES

A. In addition to the requirements of the General Provisions, conduct mixing and delivery of hot mix asphalt materials and paving operations in accordance with ANSI A10.17.

1.9 WEATHER AND SEASONAL LIMITATIONS

A. The Contractor may place Hot Mix Asphalt Pavement for use other than a traveled way wearing course provided that the air temperature as determined by an approved thermometer (placed in the shade at the paving location) is 4˚C (40˚F) or higher and the area to be paved is not frozen. The Contractor may place Hot Mix Asphalt Pavement as traveled way wearing course provided the air temperature determined as above is 10˚C (50˚F) or higher.

B. The State is divided into two paving zones as follows:

1. Zone 1 Areas north of US Route 2 from Gilead to Bangor and north of Route 9 from Bangor to Calais.
2. Zone 2 Areas south of Zone 1 including the US Route 2 and Route 9 boundaries.

C. The Contractor may place Hot Mix Asphalt Pavement for use other than a traveled way wearing course in either Zone between the dates of April 15th and November 15th, provided that the air temperature as determined by an approved thermometer (placed in the shade at the paving location) is 4°C (40°F) or higher and the area to be paved is not frozen. The Contractor may place Hot Mix Asphalt Pavement as traveled way wearing course in Zone 1 between the dates of May 1st and the Saturday following October 1st and in Zone 2 between the dates of April 15th and the Saturday following October 15th, provided the air temperature determined as above is 10°C (50°F) or higher. For the purposes of this Section, the traveled way includes truck lanes, ramps, approach roads and auxiliary lanes. Hot Mix Asphalt Pavement used for curb, driveways, sidewalks, islands, or other incidentals is not subject to seasonal limitations, except that conditions shall be satisfactory for proper handling and finishing of the mixture. Unless otherwise specified, the Contractor shall not place Hot Mix Asphalt Pavement on a wet or frozen surface, and the air temperature shall be 4°C (40°F) or higher.

1.10 EXISTING CONDITIONS

A. Existing To New Pavements: Where new pavement matches to old care shall be taken to insure proper binding of the two materials. Utilize an asphalt binding paint as required. Both existing and new surfaces shall meet in a smooth continuous plane free from variations in height or smoothness. Clean all areas to meet thoroughly prior to installation.

B. A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.

1. The geotechnical report is included elsewhere in the Project Manual.
2. Please refer to the geotechnical report for possible additional information and guidelines related to the pavement design.

1.11 DEFINITIONS

A. Deleterious material is defined as those particles of aggregate which may be crumbled in the hand and those which have an absorption greater than 3.0-percent by weight determined in accordance with AASHTO T85 modified for weight of sample. The types which are determined to be deleterious are generally highly absorptive shales, phylites, sandstones and rotten rock of various kinds.

B. Fine Aggregate

1. Fine aggregate, from an individual source or stockpile used for blending when tested for absorption as specified in AASHTO T84 (ASTM C128), shall show a percent of absorption of not more than 2.30.
2. Deleterious substances shall not exceed the following limits:

a. Maximum permissible limits, percent by weight

b. Friable particles, clay lumps, 1.5

c. AASHTO T112 (ASTM C142)

d. Other deleterious substances such as 1.0

e. shale, alkali, mica, coated grains, soft

f. and flaky particles, ASTM C295

C. Loose and Broken Pavement: Existing asphalt, bituminous or concrete pavement that is visibly unattached or separated from surrounding pavement. This includes pavement that can be physically removed by hand or depressed when stood upon. Pavement that is "Alligatored" or cracked through to the underlying layer is considered broken. Pavement with seams or longitudinal cracks spaced wider than 3 feet apart is not considered Loose or Broken.

1.12 HOT MIX ASPHALT PLANT (MDOT 401.07)

A. General Requirements (MDOT 401.071): Mixing plants shall conform to AASHTO M 156. The mixing plant shall include an efficient dust collecting system to prevent loss of fine material. The material collected may be returned to the mixture at a uniform rate and/or be discarded.

1. Performance Graded Asphalt Binder. The Contractor shall provide a valve for sampling the bituminous material, located in a circulating feed line connecting the storage tank with the mixing plant or in a line of the storage circulation system. The valve shall be in a readily accessible location offering protection from damage. The Contractor shall maintain this valve in a workable condition and provide a drainage receptacle.

B. Automation of Batching (MDOT 401.072): Batch plants shall be automated for weighing, recycling, and monitoring the system.

1. The batch plant shall accurately proportion the various materials in the proper order by weight. The entire batching and mixing cycle shall be continuous and shall not require any manual operations. The batch plant shall use auxiliary interlock circuits to trigger an audible alarm whenever an error exceeding the acceptable tolerance occurs. Along with the alarm, the printer shall print an asterisk on the delivery slip in the same row containing the out-of-tolerance weight. The automatic proportioning system shall be capable of consistently delivering material within the full range of batch sizes. When RAP is being used the plant must be capable of automatically compensating for the moisture content of the RAP.
2. Tolerances are based on the total batch weight of the Hot Mix Asphalt Pavement. The batch plant shall be able to automatically or manually adjust for all desired batch sizes. The first or last bin drawn shall be the sand bin. Allowable tolerances are as follows:

Each aggregate component	+ 1.5 percent from the cumulative target, each bin
Last Bin Drawn	+ 1.5 percent
Mineral Filler	+ 0.5 percent
Performance Graded Asphalt Binder	+0.25 percent, -0.15 percent

Zero Return (aggregate)	+ 0.5 percent
Zero Return (bituminous material)	0.1 percent

1.13 HAULING EQUIPMENT (MDOT 401.08)

A. Trucks for hauling Hot Mix Asphalt Pavement shall have tight, clean, smooth metal dump bodies which have been thinly coated with a small amount of lime solution or an approved soap solution or detergent to prevent the mixture from adhering to the bodies.

B. All truck dump bodies shall have a cover of canvas or other water repellent material capable of heat retention which completely covers the mixture. The cover shall be securely fastened on the loaded truck except when unloading.

C. All truck bodies shall have an opening on both sides which will accommodate a thermometer stem. The opening shall be located near the midpoint of the body, at least 300 mm (12 inches) above the bed.

PART 2 PRODUCTS

2.1 MATERIALS

A. All references for materials contained within this specification are drawn from the State of Maine Department of Transportation (MDOT) 12/2002, Maine State Standard Specifications latest edition.

B. Hot Mix Asphalt Pavement Mix: The Contractor shall compose the Hot Mix Asphalt Pavement with aggregate, Performance Graded Asphalt Binder (PGAB), and mineral filler if required. HMA shall be designed and tested according to AASHTO TP-4. The Contractor shall size, uniformly grade, and combine the aggregate fractions in proportions that provide a mixture meeting the grading requirements of the Job Mix Formula (JMF). The Contractor may use a maximum of 20 percent reclaimed asphalt pavement (RAP) in any base, binder or shim course, and in any wearing course placed on shoulders (excluding Urban areas). Up to 10 percent RAP will be allowed on mainline surface courses provided that the same JMF is utilized for the full width including shoulders.

C. Granular Fill: Shall be as specified in Division 31, Section Earth Moving.

1. Granular Base: Shall be as specified in Division 31, Section Earth Moving.
2. Composition of mixtures - (MDOT 401.02 - Supplemental Specification): The coarse and fine aggregate shall meet the requirements of paragraph “Aggregate Schedule.” The several aggregate fractions for mixtures shall be sized, graded and combined in such proportions that the resulting composite blends will meet the grading requirements of the following table unless otherwise shown on the drawings.

TABLE 1

COMPOSITION OF MIXTURES - CONTROL POINTS

SIEVE SIZE	GRADING			
	TYPE 19 MM	TYPE 12.5 MM	TYPE 9.5 MM	TYPE: 4.75 MM (NO. 4)

	(3/4 INCH)	(1/2 INCH)	(½ INCH)	
	PERCENT BY WEIGHT PASSING - COMBINED AGGREGATE			
37.5 MM (1 ½ INCH)				
25 MM (1 INCH)	100			
19 MM (3/4 INCH)	90-100	100		
12.5 MM (½ INCH)	-90	90-100	100	100
9.5 MM (3/8 INCH)	-	-90	90-100	95-100
4.75 MM (NO. 4)	-	-	-90	80-100
2.36 MM (NO. 8)	23-49	28-58	32-67	40-80
1.18 MM (NO. 16)	-	-	-	-
0.60 MM (NO. 30)	-	-	-	-
0.30 MM (NO. 50)	-	-	-	-
0.075 MM (NO. 200)	2-8	2-10	2-10	2-10

-- END OF TABLE 1. --

TABLE 2: VOLUMETRIC DESIGN CRITERIA

Design ESAL's (Millions)	Required Density (Percent of Gmm)			Voids in the Mineral Aggregate (VMA)(Minimum Percent)					Voids Filled with Binder (VFB) (Minimum %)	Fines/Eff. Binder Ratio
				Nominal Maximum Aggregate Size (mm)						
	Ninitial	Ndesign	Nmax	25 (1 inch)	19 (3/4 inch)	12.5 (½ inch)	9.5 (3/8 inch)	4.75 (#4)		
<0.3	???91.5	96.0	???98.0	12.0	13.0	14.0	15.0	16.0	70-80	0.6-1.4
0.3 to <3	???90.5								65-78	
3.0 to <10	???89.0								65-75*	
10 to <30										
???30										

*FOR 9.5 MM (3/8 INCH) NOMINAL MAXIMUM AGGREGATE SIZE MIXTURES, THE MAXIMUM VFB IS 76. FOR 4.75 (#4) NOMINAL MAXIMUM AGGREGATE SIZE MIXTURES, THE MAXIMUM VFB IS 80.

-- END OF TABLE 2. –

1. Aggregate Schedule: Shall meet the total percentage by weight of aggregate passing the sieve designation as defined in Table 1 of Par. 2.1.C.2 and unless indicated otherwise on contract drawings or in the specifications.

    a. Base Course: (Roadway) 19.0 mm (Lifts:2.25”min. thk./3”max thk.)

    b. Base Course: (walkways) 12.5 mm (Lifts:1.5”min. thk./2”max thk.)

    c. Finish Course (Roadways and Walkways): 9.5 mm. (Lifts:1.25”min. thk./1.75”max thk.)

    d. Fine aggregate, that material passing the 2.36 mm sieve, shall not exceed an absorption of 3.0 percent by weight as determined by AASHTO T84. The composite blend shall have a Micro-Deval value of under 18.0 or less as determined by AASHTO TP 58-99. In the event of a failure, the Washington State Degradation test of 1967 shall be run prior to rejection of the material. Material with a value of 30 or more may be accepted. Aggregates shall also meet the following Table 3 consensus properties. The Owner reserves the right to sample and test the composite aggregate for any of the following properties at any time.

TABLE 3: AGGREGATE CONSENSUS PROPERTIES CRITERIA

<table>
<tr><th>Estimated Traffic, Million 80 kN (18 kips) ESALs</th><th>ASTM D 5821 Coarse Aggregate Angularity (Minimum)</th><th>AASHTO T-304 Method A Uncompacted Void Content of Fine Aggregate (Minimum)</th><th>ASTM D 4791(8.4) Flat and Elongated Particles (Maximum)</th><th>AASHTO T176 Clay Content/Sand Equivalent (Minimum)</th></tr>
<tr><td><0.3</td><td>60/60</td><td rowspan="2">40</td><td rowspan="4">10</td><td rowspan="3">45</td></tr>
<tr><td>0.3 to <3.0</td><td>75/60</td></tr>
<tr><td>3.0 to <10</td><td>85/80</td><td rowspan="3">45</td></tr>
<tr><td>10 to <30</td><td>95/90</td><td></td></tr>
<tr><td>???30</td><td>100/100</td><td></td><td>50</td></tr>
</table>

ASTM D 5821 - "85/80” DENOTES THAT 85% OF THE COARSE AGGREGATE HAS ONE FRACTURED FACE AND 80% HAS TWO FRACTURED FACES.

AASHTO TP304 - CRITERIA ARE PRESENTED AS PERCENT AIR VOIDS IN LOOSELY COMPACTED FINE AGGREGATE, (U).

ASTM 4791 - CRITERIA ARE PRESENTED AS MAXIMUM PERCENT BY WEIGHT OF FLAT AND ELONGATED PARTICLES. (5:1 RATIO).

-- END OF TABLE 3. --

1. Temperature Requirements (MDOT 401.04): After the JMF is established, the temperatures of the mixture shall conform to the following tolerances:

    a. In the truck at the mixing plant + 10˚C (20˚F)

b. At the Paver + 10˚C (20˚F)

c. The JMF and the mix subsequently produced shall meet the requirements of Tables 2 and 3.

13.2 CONSTRUCTION EQUIPMENT

A. Mixing: Provide hot mix asphalt mixture in a mixing plant as specified herein.

B. Pavers (MDOT 401.09): Dependable and adequate for the purpose intended, properly maintained in satisfactory and safe operating condition at all times. Pavers shall be self-contained, self-propelled units with an activated screed (heated if necessary) capable of placing courses of Hot Mix Asphalt Pavement in full lane widths, shoulder or similar construction.

C. Rollers (MDOT 401.10): Rollers shall be static steel, pneumatic tire, or approved vibrator type. Rollers shall be in good mechanical condition, capable of starting and stopping smoothly, and be free from backlash when reversing direction. Rollers shall be equipped and operated in such a way as to prevent the picking up of hot mixed material by the roller surface. Use of rollers which result in crushing of the aggregate or displacement of the mixture will not be permitted. Any Hot Mix Asphalt Pavement that becomes loose, broken, contaminated, shows an excess or deficiency of Performance Graded Asphalt Binder, or is in any other way defective shall be removed and replaced at no additional cost with fresh Hot Mix Asphalt Pavement which shall be immediately compacted to conform with the adjacent area. The type of rollers to be used and their relative position in the compaction sequence shall generally be the Contractor's option, provided specification densities are attained and with the following requirements:

1. At least one roller shall be pneumatic-tired on bridges and variable depth courses as well as the first lift of pavement over gravel or a reclaimed pavement or other irregular surface.
2. Compaction with a vibratory or steel wheel roller shall precede pneumatic-tired rolling.
3. Vibratory rollers shall not be operated in the vibratory mode when checking or cracking of the mat occurs, or on bridge decks.
4. Any method which results in cracking or checking of the mat will be discontinued and corrective action taken.
5. The maximum operating speed for a steel wheel roller shall not exceed the manufacturer's recommendations.

13.3 CURBING

A. Hot mix asphalt Curbing: MDOT Type 3 Bituminous Curbing, 712.36. The asphalt cement for bituminous curb shall be of the grade required for the wearing course. The aggregate shall conform to the requirements of Table 3. The coarse aggregate portion retained on the No. 8 sieve may be either crushed rock or crushed gravel. The mineral constituents of the bituminous mixture shall be sized and graded and combined in a composite blend that will produce a stable durable curbing with an acceptable texture.

B. Concrete curbing: as specified in Section 32 13 13 Site Concrete.

C. Granite Curbing: as specified in Section 32 13 13 Site Concrete.

PART 3 EXECUTION

14.1 CONSTRUCTION PROCEDURES

A. Granular Base and Subbase: The granular base and subbase materials shall be installed in lifts not exceeding 18" and compacted to 95% modified proctor. The granular material shall be brought to the depths and grades as shown on the drawings and specified herein. Care shall be taken to insure no damage to the finish grade prior to the application of the hot mix asphalt concrete paving.

B. Plant Mix Pavements: Composition of Mixtures: The hot mix asphalt plant admixture shall be composed of aggregate, filler if required and hot mix asphalt material. The several aggregate fractions shall be sized, uniformly graded and combined in proportions that will provide a mixture meeting the grading requirements of the job-mix formula.

C. Transportation of Hot mix asphalt Mixtures (MDOT 401.08): Trucks for hauling Hot Mix Asphalt Pavement shall have tight, clean, smooth metal dump bodies which have been thinly coated with a small amount of lime solution or an approved soap solution or detergent to prevent the mixture from adhering to the bodies. Petroleum products will not be permitted for coating truck bodies. All truck dump bodies shall have a cover of canvas or other water repellent material capable of heat retention which completely covers the mixture. The cover shall be securely fastened on the loaded truck except when unloading. All truck bodies shall have an opening on both sides which will accommodate a thermometer stem. The opening shall be located near the midpoint of the body, at least 300 mm (12 inches) above the bed.

D. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided. Deliver mixture to the area to be paved in such a manner that the temperature at the time of dumping into the spreader will be higher than that specified herein. Reject any loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is not permitted.

E. Placing:

1. Surface Preparation of Underlying Course (MDOT 401.11): Prior to the laying of the asphalt (hot mix asphalt) concrete, the Contractor shall thoroughly clean the surface upon which Hot Mix Asphalt Pavement is to be placed of all objectionable material, including loose or broken pavement. Remove or clean matter by power brush or milling machine and finish with power blower or brush. When the surface of the existing base or pavement is irregular, the Contractor shall bring it to uniform grade and cross section. Milled paving shall be finished flat with a straight and square edge, free from irregularities or bulges. Hand brooms or other cleaning methods may be used if approved by Architect/Engineer. Dispose of matter in accordance with applicable Local, State and Federal codes.
2. Spraying of Contact Surfaces (Tack Coat): Spray contact surfaces of previously constructed pavement (longer than 7 days) with a thin coat of emulsified asphalt

material conforming to MDOT specifications for emulsified asphalt tack coat. Paint contact surfaces of structures with a thin coat of emulsified asphalt or other approved material prior to placing the mixture.

3. General Requirements for Use of Hot mix asphalt Spreaders: The Contractor shall place Hot Mix Asphalt Pavement with a paver using an automatic grade and slope controlled screed. The controls shall automatically adjust the screed and increase or decrease the layer thickness to compensate for irregularities in the preceding course. The controls shall maintain the proper transverse slope and be readily adjustable so that transitions and superelevated curves can be properly paved. The controls shall operate from a fixed or moving reference such as a grade wire or ski type device (floating beam) with a minimum length of 9 m (30 foot).
4. The Contractor shall operate the paver in such a manner as to produce a visually uniform surface texture and a thickness within the requirements of Subsection 40 1. 101 Surface Tolerances. The paver shall have a receiving hopper with sufficient capacity for a uniform spreading operation and a distribution system to place the mixture uniformly, without segregation in front of the screed. The screed assembly shall produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. Pavers with extendible screeds shall have auger extensions and tunnel extenders as necessary.
5. The range of temperatures of the mixtures at the time of spreading shall be between 250-degrees F and 300-degrees F. Hot mix asphalt concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected.
6. On roads opened to two way traffic, the Contractor shall place each course over the full width of the traveled way section being paved that day.
7. Hand-spreading in Lieu of Machine-spreading (MDOT 401.15): On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the Contractor shall spread, rake, and lute the mixture with hand tools to provide the required compacted thickness. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between 250-degrees F and 300-degrees F. Hot mix asphalt concrete having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected.

F. Compaction of Mixture (MDOT 401.16): Immediately after the Hot Mix Asphalt Pavement has been spread, struck off, and any surface irregularities adjusted, the Contractor shall thoroughly and uniformly compact the mixture by rolling. The Contractor shall roll the surface when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, or shoving. The Contractor shall prevent adhesion of the mixture to the rollers or vibrating compactors without the use of oil.

G. The Contractor shall immediately correct any displacement occurring as a result of the reversing of the direction of a roller or from other causes. Any operation other than placement of variable depth shim course that results in breakdown of the aggregate shall be discontinued. Any new pavement that shows obvious cracking, checking, or displacement may be removed and replaced for the full lane width as directed by the Architect/ Engineer at no cost to the Owner.

H. Along forms, curbs, headers, walls, and other places not accessible to the rollers, the Contractor shall thoroughly compact the mixture with mechanical vibrating compactors. The Contractor shall only use hand tamping in areas inaccessible to all other compaction equipment. On depressed areas, the Contractor may use a trench roller or cleated compression strips under a roller to transmit compression to the depressed area.

I. Joints (MDOT 401.17): The Contractor shall construct wearing course transverse joints in such a manner that minimum tolerances shown in section 40 1. 101 are met when measured with a straightedge. The paver shall always maintain a uniform head of material during the joint construction. The hot asphalt mix shall be free of segregation and meet temperature requirements. Transverse joints of the wearing course shall be straight and neatly trimmed. The Contractor may form a vertical face exposing the full depth of the course by inserting a header, by breaking the bond with the underlying course, or by cutting back with hand tools.

J. The Contractor shall apply a coating of emulsified asphalt immediately prior to paving all joints, except those formed by pavers operating in echelon. The Contractor shall use an approved spray apparatus designed for covering a narrow surface. The Architect/ Engineer may approve application by a brush for small surfaces, or in the event of a malfunction of the spray apparatus, but for a period of not more than one working day.

K. Where pavement under this Contract joins an existing pavement, the Contractor shall cut the existing pavement along a smooth line, producing a neat, even, vertical joint. The Architect/ Engineer will not permit broken or raveled edges.

L. All joints shall present the same texture, density, and smoothness as other portions of the course. Carefully make joints between old and new pavement or within new pavements in a manner as to ensure a thorough and continuous bond between old and new sections of the course. Paint all vertical contact surfaces of previously constructed sections with a thin uniform coat of emulsion or other approved material just before the fresh mixture is placed.

M. Curbing (MDOT 609.04)

1. Before placing the curb, the foundation course shall be thoroughly cleaned of all foreign and objectionable material. String or chalk lines shall be positioned on the prepared base to provide guide lines. The foundation shall be uniformly painted with tack coat at a rate of 0.2 to 0.7 L/m2 (0.04 to 0.14 gal/yd2).
2. The curb shall be placed by an approved power operated extruding type machine using the shape mold called for. A tight bond shall be obtained between the base and the curb. The resulting curbing shall conform in all respects to the curbing produced by the machine.
3. The curb will be sealed with bituminous sealing compound only when directed by the Engineer. Before sealing, the curb shall be clean, dry and shall have reached the ambient temperature.
4. When required, the curb shall be painted and coated with glass beads in accordance with Section 32 12 19 “Pavement Markings”. Curb designated to be painted shall not be sealed with bituminous sealing compound.

5. Curb may be accepted or rejected based on appearance concerning texture, alignment, or both. All damaged curb shall be removed and replaced at the Contractor's expense.

14.2 FIELD SAMPLING AND TESTING

A. Sampling (MDOT 401.203): One sample will be taken from the paver hopper or the truck body per 250 Mg (275 ton) per pay item. The mix will be tested for gradation and PGAB content. If the mix is within the USL and LSL tolerances listed in Table 4, the Owner will pay on the basis of the contract price outlined in the bid form and as reflected on the Contractor prepared schedule of values.

TABLE 4: GRADATION, VOLUMETRIC AND PGAB CONTENT VERIFICATION LIMITS

PROPERTY	USL AND LSL	REJECTION LIMITS
	METHOD C	
PERCENT PASSING 4.75 MM (NO. 4) AND LARGER SIEVES	TARGET + 7	TARGET + 9
PERCENT PASSING 2.36 MM (NO. 8) TO 1.18 MM (NO. 16) SIEVES	TARGET + 5	TARGET + 7
PERCENT PASSING 0.60 (NO. 30)	TARGET + 4	TARGET + 6
PERCENT PASSING 0.30 MM (NO. 50) TO 0.075 SIEVE (NO. 200)	TARGET + 3	TARGET + 5
PGAB CONTENT	TARGET + 0.5	TARGET + 0.7
AIR VOIDS	NOT APPLICABLE	NOT APPLICABLE
FINES TO EFFECTIVE BINDER	NOT APPLICABLE	NOT APPLICABLE
VOIDS IN MINERAL AGGREGATE	NOT APPLICABLE	NOT APPLICABLE
VOIDS FILLED WITH BINDER	NOT APPLICABLE	NOT APPLICABLE
IN-PLACE DENSITY	92.0 MINIMUM	-

-END OF TABLE 4-

1. Pavement and Mixture: Owner’s independent testing agency shall cut two 150 mm (6 inch) cores, which shall be tested for percent TMD, thickness and density of the completed pavements. Furnish all tools, labor and material for samples and for satisfactory replacement of pavement. Take samples and test at not less than frequency specified hereinafter and at the beginning of plant operations; for each day’s work as a minimum; each change in the mix or equipment; and as often as directed. Accomplish sampling in accordance with ASTM D979. If the test results for each 250 Mg increment are outside the USL and LSL limits (see Table 4) the following deductions (Table 4b) shall apply. If the test results for each 275 Mg increment are outside the rejection limits presented in Table 4, the 275 ton sublot is subject to removal at the discretion of the Engineer. A second consecutive failing test shall result in cessation of production.

TABLE 4B

PGAB Content	-5%
2.36 mm sieve (No. 8)	-2%
0.30 mm sieve (No. 50)	-1%
0.075 mm sieve (No. 200)	-2%
Density	-10%*

*ONLY APPLIES WHEN CALLED FOR.

-- END OF TABLE 4B --

1. Sample Identification: Furnish each sample in a clean container, securely fastened to prevent loss of material. Tag each sample for identification. The tag shall contain the following information:
    a. Contract No._____
    b. Sample No._____Quantity_____
    c. Date of Sample_____
    d. Sample_____
    e. Source_____
    f. Intended use_____
    g. For testing_____

B. Testing:

1. General Contractor to arrange for and Owner to pay for all required field testing. The General Contractor shall pay for any required retesting by the Architect and Owner.
2. Pavement Courses Tests: Density: If required, determine the representative laboratory density by averaging the density of four laboratory specimens prepared in accordance with ASTM D1559.
3. Thickness: Match thickness as shown on drawing. Variations shall be removed and replaced to the proper thickness at no additional cost to the Owner.
4. Smoothness: Check surface tolerance with a 4.9 m (16 foot) straightedge or string line placed parallel to the centerline of pavement and with a 3 m (10 foot) straightedge or string line placed transverse to the centerline of pavement. Straightedge test the compacted surface of the leveling, binder and wearing courses as the work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Unevenness of the leveling and binder course shall not vary more than plus or minus ¼-inch in 10-feet; variations in the wearing course shall not vary more than plus or minus 1/8-inch in 10-feet. The Contractor shall correct any portion of the pavement showing irregularities greater than that specified by replacing it with new material.

5. Finished Grades: The finish grades of each course placed shall not vary from the finish elevations, profiles and cross sections indicated on the drawings by more than ½-inch.

END OF SECTION 32 12 16

SECTION 32 12 19 - PAVEMENT MARKINGS

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.

1.2 SUMMARY

A. Section includes pavement markings with paint, thermoplastic compounds, or reflective media as indicated in the drawings and as specified herein. The work shall include but is not limited to the following:

1. 4” wide reflectorized white parking stall and access road travel lane delineations.
2. 4” wide reflectorized yellow access road travel lane delineations.
3. 24” wide reflectorized white “stop” lines, locations as indicated on the drawings.
4. Flat light blue handicap stalls with flat white graphics, locations as indicated on the drawings.
5. 24” wide reflectorized white crosswalk striping at 4’-0” o.c. with 4” wide reflectorized white sidelines.
6. Reflectorized white “pavement symbols” at locations as indicated on the drawings.

B. Related sections:

1. Section 01 33 00, Submittal Procedures.
2. Division 32 Section, “Asphalt Paving”

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. AMERICAN ASSOCIATION OF STATE HIGHWAY & TRANSPORTATION OFFICIALS (AASHTO)
2. AASHTO M247 1996 Standard Specification for Glass Beads Used in Traffic Paint
3. FEDERAL SPECIFICATIONS (FS)
4. FS TT-B-1325 2007 (Rev. D) Beads (Glass Spheres) Retro-Reflective
5. FS TT-P-115 1999 (Rev. F) Paint, Traffic (Highway, White and Yellow)
6. MAINE DEPARTMENT OF TRANSPORTATION (MDOT) "Standard Specifications” 12/2002

1.4 SUBMITTALS

A. Manufacturer's Catalog Data

1. Reflective Media
2. Paint
3. Thermoplastic compounds and primer

B. Manufacturer's Instructions

1. Paint

2. Thermoplastic compounds and primer
3. Submit manufacturer's Material Safety Data Sheets.

C. Statements

1. Construction equipment list

D. Factory Test Reports

1. Reflective media
2. Paint
3. Thermoplastic compounds and primer
4. Report from sampling and testing made in accordance with paragraph entitled "Sampling and Testing".

E. Certificates of Compliance: Submit certificates attesting that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the frequency or intervals specified in the publication. Other tests shall have been performed within 3 years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

1. Reflective media
2. Paint
3. Thermoplastic compounds and primer

1.5 DELIVERY AND STORAGE

A. Deliver paints, paint materials and thermoplastic compound materials in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage facilities at the job site for maintaining materials at temperatures recommended by the manufacturer.

1.6 SCHEDULES

A. Submit a written time schedule for traffic line painting. The schedule shall include paving and painting times. Provide the Architect/Engineer with 3-days notice prior to the application of any paint.

1.7 WEATHER LIMITATIONS

A. Apply paint to clean, dry surfaces, and unless otherwise approved, only when air and pavement temperatures are above 40-degrees F for oil-based materials, 50-degrees F for water-based materials, and less than 95-degrees F. Maintain paint temperature within these same limits.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide materials conforming to the requirements specified herein.

1. Paints for Roads and Streets: Paint shall be a cold-applied, acrylic latex traffic marking paint in conformance with federal specifications FS TT-P-115, Type 1; FS TT-P-75, Maine State Standard, MDOT 708.03 and the following:

    a. Color: White, Yellow, Light Blue

    b. Sheen: Flat (0-5)

    c. Volume Solids: 55% min.

    d. Weight Solids: 70% min.

    e. VOC: <100 g/L

    f. Weight/Gallon: 6.4 kg (±100 g)

    g. Coverage: 100-150-sq. ft. per gal. (15 mils wet)

    h. Drying Time: At 77-Degrees F (50% relative humidity)

        1) To Touch: 15 minutes

        2) For Traffic: 50 minutes

    i. Acceptable Products/Manufacturers are:

        1) "Zoneline" Traffic and Zone Marking Paint by PPG Porter Paints of Porter International.

        2) "Hotline" Fast Dry Latex Traffic Marking Paint by Sherman Williams.

        3) Approved equal.

    j. NOTE: Paint for temporary pavement marking shall retain the original color, adhere to the glass beads and shall be adequately durable to minimize the need for repainting.

2. Reflective Media for Roads and Streets: Shall be in conformance with FS TT-B-1325, Type I or II, Gradation A, and Maine State Standard MDOT 708.03 where glass beads conform to the requirements of AASHTO M247, Type I.

2.2 EQUIPMENT

A. Machines, tools, and equipment used in the performance of the work shall be approved by the Architect/Engineer and maintained in satisfactory operating condition.

B. Paint Applicator

1. Provide self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges. Provide equipment used for marking streets and highways capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines, or a combination of solid and intermittent lines using a maximum of three different colors of paint as specified. Provide paint applicator with

paint reservoirs or tanks of sufficient capacity and suitable gages to apply paint in accordance with requirements specified. Equip tanks with suitable air-driven mechanical agitators. Equip spray mechanism with quick-action valves conveniently located, and include necessary pressure regulators and gages in full view and reach of the operator. Install paint strainers in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Provide pneumatic spray guns for hand application of paint in areas where the mobile paint applicator cannot be used.

C. Reflective Media Dispenser: Attach dispenser for applying the reflective media to the paint dispenser and operate automatically and simultaneously with the paint applicator through the same control mechanism. Use dispenser capable of adjustment and designed to provide uniform flow of reflective media over the full width of the stripe at the rate of coverage specified herein at all operating speeds of the paint applicator to which it is attached.

D. Thermoplastic:

1. Magnum Torch or approved equivalent propane fueled torch with pressure regulator and 25 ft. of hose with adequate supply of propane
2. Infrared Thermometer
3. Gas powered blower or broom
4. Utility knife

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 20-days before application of marking materials. Pavement surfaces shall be dry and free of oil, dirt grease, and other contaminants prior to the application of pavement markings. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, existing paint markings, residual curing compounds, and other coatings adhering to the pavement by waterblasting. Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent bleeding through the new paint. Clean non conforming surfaces to a width of 4 to 6 inches wider than the proposed marking. Do not commence painting in any area until pavement surfaces are dry and clean and have been inspected and approved by the Architect/Engineer.

3.2 APPLICATION

A. Widths: The traveled way or parking lane width and width of longitudinal lines shall be as specified on the drawings. Lane widths shall be measured from the center of the lane lines once a control line is established for the lane configuration of the roadway. When

measurements are taken from existing longitudinal ilnes, the point of reference shall be the center of the single line or the center of the space between dual lines. The traveled way widths are in compliance when they have an acceptable appearance and are within a 2 inch variation from the proposed lane width.

B. Alignment: Place markings in a straight and uniform manner. Lane lines are in compliance when they have an acceptable appearance and are visually in alignment, with no more than a 3/8 inch variation in any 40 ft. section. Maintain longitudinal alignment through all intersections and breaks, even though the lines themselves may discontinue. Do not apply pavement line markings over longitudinal joints; offset the markings 2in.

C. Layout Markings: Remove layout markings that detract from the overall appearance and function of the final markings as determined by the engineer at no additional cost to the owner.

1. Marking Removal: Remove existing pavement markings that conflict with new or altered traffic patterns. Use an approved method and ensure that the pavement surface is not damaged. (Using paint to cover conflicting paint lines is not an acceptable method) If damage occurs, repair or replace damages, to an acceptable manner equal or better than existing conditions, at no additional cost to the owner.

D. Rate of Application

1. Reflective Markings: Apply paint evenly to the pavement area to be coated at a rate of 105 (plus or minus 5) square feet per gallon at a minimum of 15-mils of wet thickness. Apply glass spheres uniformly to the wet paint on road and street pavement at a rate of 6 (plus or minus 0.5)-pounds of glass spheres per gallon.
2. Nonreflective Markings: Apply paint evenly to the pavement surface to be coated at a rate of 105 (plus or minus 5) square feet per gallon.

E. Painting: Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. Discontinue painting operations if there is a deficiency in drying of the markings until cause of the slow drying is determined and corrected.

F. Reflective Media: Application of reflective media shall immediately follow the application of paint. Accomplish drop-on application of the glass spheres to ensure even distribution at the specified rate of coverage. Should there be malfunction of either paint applicator or reflective media dispenser, discontinue operations until deficiency is corrected.

G. Thermoplastic Compound: Place thermoplastic pavement markings upon dry pavement. At the time of installation the pavement surface temperature shall be a minimum of 40 degrees F and rising Prior to any heating. Rolled tape products shall be unrolled when the temperature is a sustained minimum of 55 degrees F. Thermoplastics, as placed, shall be free from dirt or tint. Heat the targeted surface area to 300 degrees F (or as specified by the manufacturer) immediately place the first piece. Apply all centerline, skipline, edgeline,

and other longitudinal type markings with a mobile applicator. Maintain a minimum distance of 6 inches between the torch nozzle and the heat source. Place all special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable applicator, using the extrusion method.

3.3 FIELD TESTING AND INSPECTION

A. Inspection: Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.

1. Surface Preparations and Application Procedures: Surface preparations and application procedures will be examined by the Architect/Engineer to determine conformance with the requirements specified. Approve each separate operation prior to initiation of subsequent operations.
2. Records: Maintain complete records of quality control inspection results, including actions taken to correct problems. Identify the following for the record

    a. Ambient Temperature

    b. Pavement surface temperature

    c. Material Temperature

    d. Material Thickness

    e. Retroreflectivity

    f. Alignment

    g. Color

    h. Product name

3. Observation Period:

    a. The contractor shall be responsible for any defects in material and workmanship of the pavement markings for a period of 180 days from the date the pavement is opened to traffic.

    b. Time charges will not be assessed during the observation period provided all other work on the contract is complete. At the end of the observation period, the engineer can inspect the pavement markings for durability, color, and retroreflectivity, and inform the contractor that the pavement markings have failed and that they require corrective action. Pavement markings will be failed for any of the following conditions:

        1) More than 5 percent of the substrate is exposed in any section of longitudinal marking up to a 2,000 ft maximum inspection area.

        2) Retroreflectivity values have dropped below the minimum retroreflectivity specified.

        3) Marking is discolored when compared visually with the color chips.

4) Remove and replace all failed markings within 30 days of receiving written notification from Engineer.

3.4 TRAFFIC CONTROL AND PROTECTION

A. Protect the markings until dry. Place warning signs (as per the MUTCD and as approved) near the beginning of the work site and well ahead of the work site for alerting approaching traffic from both directions. Place small markers along newly painted lines to control traffic and prevent damage to newly painted surfaces. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation. If a vehicle damages uncured markings, reapply the markings and removed the marks left on the pavement by the vehicle at no additional cost to the owner.

END OF SECTION 32 12 19

SECTION 32 13 13 - SITE 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. Section includes exterior cement concrete pavement for the following:

1. Equipment Pads
2. Concrete Curbing

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
2. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Qualification Data: For manufacturer.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates.

D. 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.

E. Shop Drawings:

1. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, bent bar diagrams, bar arrangement, splices and laps, and supports for concrete reinforcement.
2. Construction and Control Joints Shop Drawings: The contractor shall provide shop drawings showing locations of control and construction joints to the landscape

architect for review prior to placement of concrete for the plazas and sidewalks. Include any other visual features including the brooming pattern, color concrete section, etc. as called for in the drawings.

F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Admixtures.
2. Applied finish materials.
3. Bonding agent or epoxy adhesive.
4. Joint fillers.
5. Saltguard Sealant

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency 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 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Preinstallation 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 pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:

a. Contractor's superintendent.

b. Independent testing agency responsible for concrete design mixtures.

c. Ready-mix concrete producer.

d. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. 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.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

C. Recycled Content of Steel Products: Provide products with an average recycled content of steel with postconsumer recycled content not less than 75 percent and preconsumer recycled content not less than 10 percent.

2.3 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.
2. Include Supplementary Cementitious Materials as a percentage of cementitious materials at 25% by weight:

a. Fly Ash: ASTM C 618, Class C or F.

b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Water: Potable.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips:

1. Acceptable Products:

a. Ceramar Flexible Foam Expansion Joint

1) Meeting ASTM D 5249, Type2; ASTM D 1752; ASTM D 7174-05

b. Asphalt-saturated cellulosic fiber.

1) Meeting ASTM D 1751

B. Concrete Water Repellent Agent: Clear liquid concrete surface penetrating agent that protects concrete from moisture intrusions and chemical attack of chloride salts. Apply to all exterior concrete surfaces.

1. Available Products:

a. Vexcon Powerseal 40

b. PROSOCO, Inc.; Consolideck Saltguard WB

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. General site concrete:

1. Proportion mixtures to provide normal-weight concrete with the following properties:

a. Compressive Strength (28 Days): 3,000 psi

b. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.

c. Slump Limit: 5 inches plus or minus 1 inch.

d. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

e. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

C. Higher-strength site concrete:

1. Proportion mixtures to provide normal-weight concrete with the following properties:
    a. Compressive Strength (28 Days): Either 4,500 psi or 5,000 (as indicated on dwgs.)
    b. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
    c. Slump Limit: 4 inches plus or minus 1 inch.
    d. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
    e. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F 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.

2.8 CURBING

A. Slip Form Concrete Curb

1. 1. Provide slip form concrete curbing shapes and configurations as shown on the drawings. Curbing size shall be manufacturer’s standard curbing sections. Type of configuration shall be approved by the Owner and the Architect. Concrete curbing shall have a 4,500 psi compressive strength at 28 days. Curbing sections shall be reinforced as per manufacturer’s recommendation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
2. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Control Joints: From weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints by sawcutting for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of control joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

M. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

O. 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 air temperature has fallen to or is expected to fall below 40 deg F uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg Ft point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg Ft 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. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 CURBING

A. Slip Form Concrete Curb

1. Remove loose material from compacted subbase surface immediately before placing concrete.
2. Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
3. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.8 CONCRETE FINISHING

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, 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. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish.

C. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route or as specified on the construction plans. Coordinate required final finish with Architect before application.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.

b. Continuous water-fog spray.

c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

E. All exterior concrete surfaces shall be provided with a water repellent product equal to Vexcon Powerseal 40 or Consolideck Saltguard WB. Apply product per manufacturer’s

recommendations. In some cases the concrete must cure for 28 days before applying product, check with manufacturer.

3.10 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch
2. Thickness: Plus 3/8 inch minus 1/4 inch
3. Surface: Gap below 10-foot-g, unleveled straightedge not to exceed 1/4 inch
4. Joint Spacing: 3 inches
5. Contraction Joint Depth: Plus 1/4 inch no minus.
6. Joint Width: Plus 1/8 inch no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: The Site Contractor shall pay for any required retesting by the Architect and Owner.

B. Testing Services: 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 1 composite sample for each 5000 sq. ft. or fraction thereof of each concrete mix 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.

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 mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; 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; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.

a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 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.

D. 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.

E. 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.

F. 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.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 13 73 - CONCRETE PAVING 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 the following:

1. Expansion and contraction joints within cement concrete pavement.
2. Joints between cement concrete and asphalt pavement.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
2. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
3. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

1.4 QUALITY ASSURANCE

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

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

1.5 PROJECT CONDITIONS

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

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer 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. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 PRODUCTS

2.1 MATERIALS

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

B. Colors of Exposed Joint Sealants: Match concrete color.

2.2 JOINT-SEALANT BACKER MATERIALS

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

B. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.3 PRIMERS

A. Primers: Product 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.

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.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or 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.

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

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

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

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

1. Place joint 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. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

A. Clean off excess joint 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.

3.5 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 and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION 32 13 73

SECTION 32 14 00 - UNIT PAVING SET ON PAVEMENT

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. Clay pavers set in bituminous setting beds.
2. Bedding and joint sand.
3. Asphalt setting bed.
4. Edge restraints.

B. Related Sections:

1. Division 32 Section "Asphalt Paving" for asphalt setting beds under unit pavers.
2. Division 32 Section "Site Concrete" for concrete slabs used as base.

1.3 REFERENCES

A. American Society of Testing and Materials (ASTM) (latest edition):

1. C 33 Specification for Concrete Aggregates.
2. C 136 Method for Sieve Analysis for Fine and Coarse Aggregate.
3. C 140 Sampling and Testing Concrete Masonry Units.
4. C 144 Standard Specifications for Aggregate for Masonry Mortar.
5. C 936 Specifications for Solid Interlocking Concrete Paving Units.
6. C 979 Specification for Pigments for Integrally Colored Concrete.
7. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.
8. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.
9. D 2940 Graded Aggregate Material for Bases or Subbases for Highways or Airports.
10. C 29 Bulk Density and Voids in Aggregate Materials.

1.4 ACTION SUBMITTALS

A. Shop or product drawings and product data shall be submitted. The layout, pattern, and relationship of paving joints to fixtures and project formed details shall be indicated.

B. Test results shall be submitted from an independent testing laboratory for compliance of paving unit requirements to ASTM C 936 or other applicable requirements.

C. Product Data: For the following:

1. Pavers.
2. Bituminous setting materials.
3. Edge restraints.

D. Samples for Initial Selection: For each type of unit paver indicated and the following:

1. Joint materials involving color selection.
2. Exposed edge restraints involving color section.

E. Samples for Verification:

1. Full-size units of each type of unit paver indicated.

F. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

1.5 QUALITY ASSURANCE

A. Installation shall be by a contractor and crew with at least one year of experience in placing interlocking concrete pavers on projects of similar nature or dollar cost.

B. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. A 9 ft. x 9 ft. paver area shall be installed as described in Article 3.6.
2. This area will be used to determine joint sizes, lines, laying pattern(s), color(s), and texture of the project.
3. This area shall be the standard from which the work will be judged.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store pavers 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.

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 asphalt cement and other bituminous materials in tightly closed containers.

1.7 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.

PART 2 PRODUCTS

2.1 CLAY PAVERS

A. Pavers: Solid interlocking paving units.

B. Basis of Design: All sizes and colors listed are listed on the drawings.

2.2 EDGE RESTRAINTS

A. Edge Restraints: Shall be “Asphalt Edge” by Pemaloc Inc. or approved equal.

B. Color: Black

2.3 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with requirements in Division 31 Section "Earth Moving" for base course.

B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.

2.4 ASPHALT MATERIALS

A. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.

B. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

2.5 BITUMINOUS SETTING-BED MATERIALS

A. Fine Aggregate for Setting Bed: Refer to Section 31 20 00.

B. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.

C. Setting bed primer/adhesive for adhesion to concrete base material:

1. Cut Back Asphalt Specification (Rapid Curing Type), per ASTM D 2028 and AASHTO M-81.

D. Neoprene-Modified Asphalt Adhesive for bonding Concrete Pavers to Bituminous Bedding Material:

1. Standard neoprene modified asphalt adhesive containing oxidized asphalt combined with 2% neoprene and 10% long fibered mineral fibres containing no asbestos with a softening point of 155 degrees F.

E. Preformed Asphalt Joint Filler:

1. ASTM D 994, ½ inch thick, for expansion joints which are detailed.

F. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to 300 deg F.

TABLE 2

BEDDING SAND GRADING REQUIREMENTS

ASTM C 33	
SIEVE SIZE	PERCENT PASSING
3/8 IN. (9.5 MM)	100
NO. 4 (4.75 MM)	95 - 100
NO. 8 (2.36 MM)	85 - 100
NO. 16 (1.18 MM)	50 - 85
NO. 30 (600 µM)	25 - 60
NO. 50 (300 µM)	10 - 30
NO. 100 (150 µM)	2 - 10

END OF TABLE 2

5.1 JOINT SAND

A. Joint sand shall be Unicare Polymeric Sand Max by Unilock or approved equal.

B. Color: Grey

5.2 2.7 PAVER SEALER

A. PAVER SEALER SHALL BE UNICARE JOINT SAND STABILIZING SEALER BY UNILOCK OR APPROVED EQUAL

PART 3 EXECUTION

7.1 EXAMINATION

A. Examine areas indicated to receive paving, 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.

C. Verify that subgrade preparation, compacted density and elevations conform to the specifications.

D. Verify that geotextiles, if applicable, have been placed according to specifications and drawings.

E. Verify that aggregate subbase materials, thickness, compaction, surface tolerances and elevations conform to the specifications.

F. Verify that the asphalt base is ready to install the bituminous bedding layer.

G. Beginning the installing of the bituminous bedding layer and paver installation shall signify acceptance of the asphalt base and edge restraints.

7.2 PREPARATION

A. Sweep hard substrates to remove dirt, dust, debris, and loose particles.

7.3 EDGE RESTRAINTS

A. Adequate edge restraint shall be provided along the perimeter of all paving as specified. The face of the concrete edge restraint, where it abuts pavers, shall be vertical down to the subbase.

B. All edge restraints shall be constructed to dimensions and level specified and shall be supported on a compacted subbase not less than 6 in thick.

7.4 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Joint Pattern: As indicated on drawings.

E. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

F. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. Install job-built concrete edge restraints to comply with requirements in Division 03 Section "Cast-in-Place Concrete."

7.5 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

D. Treat leveling course with herbicide to inhibit growth of grass and weeds.

E. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight

against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

F. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

G. Fill joints immediately after vibrating pavers into leveling course.

H. Do not allow traffic on installed pavers until sand has been vibrated into joints.

7.6 BITUMINOUS SETTING BED APPLICATIONS

A. Preparing the bituminous setting bed material prior to the installation of the concrete paving stones:

1. Apply setting bed primer/adhesive to concrete base according to manufacturer’s direction, to bond the bituminous bedding material to the concrete base.
2. Install the setting bed over the base surface (typically prepared by others), place 1” deep control bars directly over the concrete base. If grade must be adjusted, set thin wooden shims under the depth control bars to adjust the proper grade. Set two bars parallel to each other approximately eleven (11) feet apart to serve as guides for the striking boards (12 ft long x 2 in x 6 in board). The depth control bars must be set carefully to bring the bedding material to proper grade, to insure proper paving stone finished height.
3. Place bituminous bedding material between the parallel control bars. Pull this bedding material with the striking board over the depth control bars several times. After each passage, any void must be filled with fresh bituminous material to produce a smooth, firm and even setting bed. As soon as this initial panel is completed, advance the first depth control bar to the next position, in readiness for striking the next panel. Carefully fill any voids that remain, after removing the depth control bars and any wooden adjustment shims.
4. The setting bed shall be rolled with a power roller. The roller (check with the manufacturer for proper machinery specifications) should be equipped with a water tank and have the capacity to fully consolidate the bituminous bedding mixture to a

nominal depth of ¾ inch, while still hot. The setting bed thickness shall be adjusted so that the concrete pavers will be at the required finished grade. (Adjustments in the setting bed should be performed to keep the setting bed thickness at ¾ inches or as close as possible.) Proper attention to elevations during the construction of the concrete base material will insure maintaining the required nominal ¾ inch thick bituminous setting bed.

5. After the setting bed material has cooled, a coating of two (2) percent Neoprene-Modified Asphalt Adhesive is applied by mopping, squeegeeing or troweling over the top surface of the bituminous setting bed to provide a bond between the pavers and the bituminous setting bed. If utilizing the troweling method, the trowel shall have a serrated edge that does not exceed one – sixteenth (1/16) of an inch.

B. Installing paving stones: After the application of the 2% Neoprene-Modified Asphalt Adhesive, allow 2-3 hours open air time or until the adhesive material becomes tacky and just skins over prior to laying the paving stones. Once the 2% Neoprene-Modified Asphalt Adhesive is ready for use, carefully place the paving stones by hand in straight courses with hand tight joints and uniform top surface. Good alignment must be kept, and the pattern shall be that shown on the plans.

7.7 PAVER JOINTS

A. Install joint sand per manufacturers recommendations.

B. Repeat joint-filling process 30 days later.

7.8 PAVER SEALING

A. Seal pavers up on completion of jointing sand installation. Seal per manufacturers recommendations.

7.9 OTHER CONDITIONS

A. Place a pre-molded, non-extruded, and resilient expansion joint against all vertical walls with flashing to within one (1) inch of finished grade.

7.10 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION 32 14 00

SECTION 32 16 15 - PRECAST CONCRETE UTILITY 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. This Section includes the following types of precast concrete

1. Communication Vaults for use in communication line installation

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork: Section 31 00 00.

B. Concrete Paving Joint Sealants: Section 32 13 73.

1.4 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for precast units.

B. Shop Drawings of all items specified herein shall be submitted for approval in accordance with the requirements of Section 01 33 00 - Submittals. Shop Drawings shall show size, arrangement of incoming and outgoing lines, concrete strength, and reinforcing. Approval must be received before fabrication is started.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, damp proofing and accessories.
2. Materials for Metal Work (frames and covers)

C. Submit submittal packages in accordance with Standard Specification Section 01 30 0. B. Submit manufacturer's catalog data on precast concrete items. Show dimensions of vault and location of openings including thicknesses of walls, floor and top slab. Show reinforcing wire and steel. Show materials of construction by ASTM reference and grade. C. Submit manufacturer's design calculations and certification signed and sealed by a professional civil or structural engineer registered in the State of California that vault design and construction comply with the specified design load conditions and the referenced ASTM specification (e.g., ASTM C 857 and C 858). D. Submit manufacturer's catalog data, descriptive literature, and installation instructions for the waterproofing material.

D. Quality Control Submittals:

1. Test Reports: Random freeze thaw tests shall be conducted by the manufacturer. Test specimens shall retain 60 percent of its initial modulus of elasticity after 300 cycles. Test results shall be made available to the Director upon request.

1.5 INSPECTIONS

A. The owner's Representative or his authorized representative will conduct an inspection of the precast fabrication process at the manufacturer's plant prior to the placement of the concrete into the formwork. The inspection will review the quality of materials, the formwork, placement of reinforcing steel, location of openings in the vault, and other construction details as shown in the approved fabrication drawings in the submittal package. If the concrete is placed into the formwork without this prior inspection, the vault will be rejected.

B. The owner's Representative or his authorized representative will conduct a second inspection of the vault and trench box upon its arrival at the jobsite but before placed in earth. The inspection will review the quality of the concrete surfaces, defects that indicate any imperfect concrete mixing and molding, surface deflects indicated by honey-combed or open texture and damaged areas, any exposed or bare reinforcing steel, and waterproofing that is missing from indicated surfaces or poorly applied. If any of these items are present or exist, the vault will be rejected.

1.6 PROJECT CONDITIONS

A. Interruptions of Existing Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Facility's written permission

PART 2 PRODUCTS

4.1 MANUFACTURERS

A. Provide precast concrete units per the drawings unless manufacturer has a mold that differs.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified by American Concrete Company, Superior Concrete or approved equal.

4.2 MATERIALS

A. Provide precast concrete with a minimum compression strength of 5000 pounds per square inch. Castings shall have plane smooth surfaces, true to line and face, free from defects, sharp arises, and with curved surfaces accurately reproduced. Overall dimensions for each casting shall not vary more than 1/16 inch from those indicated.

B. Precast units shall be cast at the manufacturers plant. Job site castings will not be permitted.

4.3 VAULTS

A. Precast vaults shall comply with ASTM C 858 except as modified herein.

B. Design live and dead loads shall be in accordance with ASTM C 857. Design precast concrete vaults to withstand site soil conditions and traffic loading of A-16 per Table 1 of ASTM C 857 with a 30% increase due to impact. Soil lateral loads shall be as determined by ASTM C 857. Alternate design by the strength design method shall include a load factor of 1.7 times the lateral earth or hydrostatic pressures.

C. Design shall also comply with the following restrictions: 1. The maximum reinforcement ratio allowed is one-half the reinforcement ratio that would produce a balanced strain condition. 2. Earth pressure shall be converted to a horizontal pressure using a coefficient of earth pressure at rest of 0.5 and not a coefficient of active earth pressure. 3. Include a live load surcharge of 2 feet of soil in the design of the walls.

D. Precast vault construction shall be in the form of monolithic walls or horizontal wall sections; do not use panel walls.

E. Minimum wall thickness shall be 6 inches. Design knockout wall panels to accommodate loading pressures defined above.

F. Design and construct vaults to be watertight when subjected to groundwater over the entire height of the vault.

1. Include rubber-gasketed joints

G. Provide openings in precast vaults for piping and access. Provide cast in place inserts in the roof slab and end walls at the locations as shown on the Drawings. No field coring of openings is allowed

4.4 TRENCHBOX

A. Trenchbox: precast boxes shall comply with ASTM C 858 except as modified herein

B. Precast unit construction shall be in the form of monolithic walls or horizontal wall sections; do not use panel walls.

C. Minimum wall thickness shall be 6 inches.

D. Design and construct units to be watertight when subjected to groundwater over the entire height of the unit.

E. Include rubber-gasketed joints

F. Provide openings in precast units for piping and access. Provide cast in place inserts in the roof slab and end walls at the locations as shown on the Drawings. No field coring of openings is allowed

4.5 SEALANTS AND MORTAR

A. Fill joints between precast sections with a double layer of plastic sealing compound and make watertight. Fill with mortar all recesses, lifting inserts, or other cavities not filled with plastic sealing compound. Mortar shall comply with ASTM C 387, Type S.

4.6 CEMENT

A. Cement shall be ASTM C 150, Type II

4.7 WATERPROOFING

A. As specified on the drawings.

4.8 APPURTENANCES

A. Provide ladders, covers and frames, supports, inserts, eyebolts, and other miscellaneous metalwork, unless otherwise noted.

1. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of unit to finished grade is less than 60 inches
2. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
3. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch- diameter cover.

a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.

b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.

PART 3 EXECUTION

5.1 EXCAVATING AND BACKFILLING FOR VAULTS

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving for Utilities."

B. Unless otherwise noted, provide 6-inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend 12 inches beyond the edges of the vault. After repairing the waterproofing, backfill and compact around the vault with structural backfill material. Excavated material may be used for structural backfill provided it conforms to the Standard Specifications for structural backfill material.

5.2 INSTALLING VAULTS AND RISERS

A. Set each precast concrete vault section or riser plumb on a double layer bed of sealant at least 1/2-inch thick to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.

B. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

5.3 WATERPROOFING

A. Waterproofing shall be factory applied to all exterior surfaces of vaults and risers. This includes the bottom of the vault to be coated as an exterior surface. Apply two coats at a rate of 65 square feet per gallon per coat. Prior to backfilling, field apply waterproofing

material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

B. Repair and restore protective coatings to original condition.

5.4 FIELD QUALITY CONTROL

A. Field Tests for Concrete: Field testing requirements are covered in Section 03 30 00

B. The owner's rep may conduct additional tests at their discretion.

END OF SECTION 32 16 15

SECTION 32 16 23 - SIDEWALKS

PART 2 PRODUCTS

END OF SECTION 32 16 23

SECTION 32 17 26 - TACTILE WARNING SURFACING

PART 2 PRODUCTS

1.1 MATERIALS

END OF SECTION 32 17 26

SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 2 PRODUCTS

1.1 COMPONENTS

A. Line Posts: 1.9 inch (48 mm) diameter.

B. Corner and Terminal Posts: 2.38 inch (60 mm) diameter.

C. Fabric: 2 inch (51 mm) diamond mesh interwoven wire, 6 gauge, 0.1920 inch (4.9 mm) thick, top selvage knuckle end closed, bottom selvage twisted tight.

D. Tension Wire: 6 gauge, 0.1920 inch (4.9 mm) thick steel, single strand.

E. Tie Wire: Aluminum alloy steel wire.

1.2 MATERIALS

A. Posts, Rails, and Frames: _____:

1. Line Posts: Type I round in accordance with FS RR-F-191/1D.
2. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.

B. Wire Fabric: _____:

END OF SECTION 32 31 13

SECTION 32 33 00 - SITE FURNISHINGS

PART 2 PRODUCTS

END OF SECTION 32 33 00

SECTION 32 92 00 - TURFS 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. Erosion-control material(s).

B. Related Sections:

1. Division 01 Section “Temporary Tree and Plant Protection for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
3. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture as recommended by testing agency.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

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.

C. Qualification Data: For qualified landscape Installer.

D. Product Certificates: For soil amendments and fertilizers, from manufacturer.

E. Material Test Reports: For imported or manufactured topsoil.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

1.5 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 Division 01 Section "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 shall have certification in one of the following categories from the Professional Landcare Network:

a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.

b. Certified Turfgrass Professional, designated CTP.

c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

5. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
6. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for turf growth.

a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.6 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 conformance 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" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. 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 fertilizers, lime, and soil amendments with appropriate certificates.

1.7 PROJECT 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 Substantial Completion.

1. Spring Planting: April 15th – June 15th.
2. Fall Planting: August 15th – September 30th.

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.

1.8 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. 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: 60 days from date of Substantial Completion.

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: 30 days from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows:

C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Lawn Areas

a. 33% Tar Heel II Tall Fescue

b. 33% Matador GT Tall Fescue

c. 33% Pure Gold Tall Fescue

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 No. 8 sieve and a minimum of 75 percent passing through 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 No. 60 sieve.
3. Provide lime in form of ground dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: 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 3/4-inch sieve; soluble salt content of 5 to 10 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.

2.4 FERTILIZERS

A. 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 soil-testing laboratory.

2.5 PLANTING SOILS

A. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources or reuse amended topsoil from site. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land bogs or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, 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 harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

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. 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.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

D. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.7 PESTICIDES

A. General: Pesticide, registered and approved by 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 Non-Selective): 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 Non-Selective): 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.

C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 4-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

1. Products: Subject to compliance with requirements, provide the following:

a. Mirafi 700X

b. Supergro or equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

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. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling 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 and which is too 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 hydroseeding and hydromulching overspray.
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. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply fertilizer directly to subgrade before loosening.

2. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

    b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. 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 mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. 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.

E. 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. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at manufacturers recommended rate for seed type.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where shown 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 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, 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. 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 TURF MAINTENANCE

A. 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 tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 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 to a height of 3 inches.

D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by 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 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.9 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with 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 Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.10 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. 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.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 33 05 00 - COMMON WORK UTILITIES

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. Piping joining materials.
2. Transition fittings.
3. Sleeves.
4. Piping system common requirements.
5. Concrete bases.
6. Metal supports and anchorages.

B. Related sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities procedures.
2. Division 22 Section "Plumbing" for roof drain connections.
3. Division 32 Section "Turf and Grasses, Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
4. Division 31 Section "Earth Moving for Utilities" for soil materials, excavating, backfilling.
5. Division 31 Section "Dewatering" for requirements and guidelines for dewatering procedures.
6. Division 31 Section “Excavation Support and Protection" for requirements and guidelines for dewatering procedures.

1.3 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed 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.

C. ABS: Acrylonitrile-butadiene-styrene plastic.

D. PVC: Polyvinyl chloride plastic.

1.4 QUALITY ASSURANCE

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

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.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

B. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Division 03.

PART 2 PRODUCTS

2.1 PIPING JOINING MATERIALS

A. 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 otherwise 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
3. PVC to ABS Piping Transition: ASTM D 3138.

2.2 TRANSITION FITTINGS

A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

1. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.3 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Division 22 Section "Common Work Results for Plumbing."

B. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

A. Install piping according to the following requirements and Division 33 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 the Coordination Drawings.

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 to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

J. Verify final equipment locations for roughing-in.

K. Refer to equipment specifications in other Sections for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 33 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Plastic Piping Solvent-Cemented 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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. PVC Nonpressure Piping: Join according to ASTM D 2855.
4. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.4 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION 33 05 00

SECTION 33 41 00 - STORM UTILITY WATER DRAINAGE

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 covers work related to storm collection and conveyance systems shown on drawings and specifications. This includes the stormwater treatment BMPs.

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities procedures.
2. Division 32 Section "Turf and Grasses, Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
3. Division 31 Section "Earth Moving for Utilities" for soil materials, excavating, backfilling.
4. Division 31 Section "Dewatering" for requirements and guidelines for dewatering procedures.
5. Division 31 Section “Excavation Support and Protection" for requirements and guidelines for dewatering procedures.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
2. AASHTO M198 1998 Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
3. AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)
4. ACPA 01-102 1988 Concrete Pipe Handbook
5. ACPA 01-103 1978 Concrete Pipe Installation Manual
6. AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)
7. ANSI A14.3 2008 Ladders - Fixed – Safety Requirements
8. AMERICAN RAILWAY ENGINEERING ASSOCIATION (AREA)
9. AREA MRE-CHP.1-5 1993 Manual for Railway Engineering (Fixed Properties): Chapter 1, Part 5, Pipelines
10. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
11. ASTM A48 2003 (Rev. 2008) Gray Iron Castings
12. ASTM A525 1987 General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
13. ASTM A536 1984 (Rev. 2004) Ductile Iron Castings
14. ASTM A760 2006 Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

15. ASTM A762 2008 Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
16. ASTM A798 2007 Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
17. ASTM A819 1984 Steel Sheet, Aluminum-Coated Type 2 for Storm Sewer and Drainage Pipe
18. ASTM A849 2000 (Rev. 2005) Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
19. ASTM B745 1997 (Rev. 2005) Corrugated Aluminum Pipe for Sewers and Drains
20. ASTM B788 2004 Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe
21. ASTM C14 2007 Nonreinforced Concrete Sewer, Storm Drain, Culvert Pipe
22. ASTM C76 2008 (Rev. A) Reinforced Concrete Culvert Storm Drain and Sewer Pipe
23. ASTM C109 2008 Compressive Strength of Hydraulic Cement Mortars (Using 2-in or 50-mm Cube Specimens)
24. ASTM C150 2007 Portland Cement
25. ASTM C361 2008 Reinforced Concrete Low Head - Pressure Pipe
26. ASTM C443 2005 (Rev. A) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
27. ASTM C478 2009 Precast Reinforced Concrete Manhole Sections
28. ASTM C923 2008 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
29. ASTM D1784 2008 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
30. ASTM D2680 2001 (Rev. 2009) Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
31. ASTM D2729 2003 Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
32. ASTM D3034 2008 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
33. ASTM D3212 2007 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
34. ASTM D4101 2008 Polypropylene Plastic Injection and Extrusion Material
35. ASTM F402 2005 Safe Handling of Solvent Cements Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
36. ASTM F2648 2007 2 to 60 inch Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications
37. AMERICAN WELDING SOCIETY, INC. (AWS)
38. AWS D1.1 1992 Structural Welding Code Steel
39. FEDERAL SPECIFICATIONS (FS)
40. A-A-60005 (Rev. 2) Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
41. FS TT-C-490 2002 (Rev. E) Cleaning Methods for Ferrous Surfaces and Pretreatments for Organic Coatings
42. MILITARY SPECIFICATIONS (MIL)
43. DOD-P-15328 (Rev. D) (Amd. 1) Primer (Wash), Pretreatment, (Formula No. 117 for Metals) (Metric)
44. UNI-BELL PLASTIC PIPE ASSOCIATION (UNI)
45. UNI B5 1989 Installation of Polyvinyl Chloride (PVC) Sewer Pipe (Replaced by ASTM D2321)

1.4 SUBMITTALS

A. Manufacturer's Catalog Data

1. Pipes (each type)
2. Fittings
3. Joints and couplings
4. Cleanouts

B. Drawings

1. Precast concrete manholes/catch basins
2. Metal work

C. Certificates of Compliance: Submit certificates attesting that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the frequency or intervals specified in the publication. Other tests shall have been performed within 3 years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

1. Pipe and fittings, including factory-applied linings
2. Pipe joint materials
3. Ductile-iron frames, covers, and gratings
4. Precast concrete manhole sections/catch basins

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage

1. Piping: Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.
2. Metal Items: Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.
3. Cement, Aggregates, and Reinforcement: Store as specified in Section 03 30 00, "Cast-In-Place Concrete."

B. Handling: Handle pipe, fittings, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care not to damage coating and paving on pipe and fittings; if damaged, make repairs. Carry, do not drag pipe to trench.

PART 2 PRODUCTS

2.1 PIPELINE AND CULVERT MATERIALS

A. HDPE Composite Plastic Piping

1. HDPE Composite Plastic Pipe and Fittings: High Density Polyethylene (Hdpe) composite pipe and fittings.

a. Hancor "Hi-Q" or "Titeline".

b. The prescribed sizes of pipes are nominal inside diameter. Pipes shall be of the size and length shown on the drawings.

2. Corrugated Polyethylene Pipe: The products supplied under this specification shall be high density polyethylene corrugated exterior/smooth interior pipe. 4 through 60 inch shall meet ASTM F2648. Material for pipe production shall be an engineered compound of virgin and recycled high density polyethylene conforming with the minimum requirements of cell classification 424420C (ESCR Test Condition B) for 4- through 10-inch diameters, and 435420C (ESCR Test Condition B) for 12- through 60-inch diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%.
3. Joint and Fittings: Pipe joints and fittings shall conform to ASTM F2306, AASHTO M252 or AASHTO M294, or be approved by the Engineer.

B. Composite Plastic Piping

1. ABS Composite Plastic Pipe and Fittings: Acrylonitrile-Butadiene Styrene (ABS) or Poly(Vinyl Chloride) (PVC) composite pipe and fittings, ASTM D2680.
2. Jointing Materials for ABS Composite Plastic Piping: ASTM D2680 solvent cement and primer or ASTM D3212 elastomeric gasket joints. Ends of pipe and fittings shall be suitable for either Type SC or Type OR joints.

C. Polyvinyl Chloride (PVC) Plastic Piping

1. PVC Plastic Pipe and Fittings: Provide bell and spigot type PVC pipe in sizes, locations, and at grades as indicated on the Drawings. Pipe shall conform to ASTM D3034 for SDR 35 pipe; PVC resin compound shall conform to ASTM D1784; lock in rubber sealing rings shall conform to ASTM D3212 and ASTM D477. Standard laying lengths shall be 12.5-feet. All joints shall be flexible providing for linear expansion and contraction. Provide manufacturer's standard lubricant. Acceptable products/manufacturers are:

a. Ipex Inc

b. North American Pipe

c. Hancor

d. Or approved similar or equal.

D. Detection Materials: Provide detectable tape, or detection plates at all buried clean outs.

2.2 CONCRETE MATERIALS

A. Precast Concrete and Associated Materials

1. Precast Concrete Manhole Sections: Precast concrete manhole risers, base sections, and tops shall conform to ASTM C478. Base and first riser shall be monolithic. All concrete shall have a minimum compressive strength of 4,000 - psi at 28-days. Components shall be designed for a H-20 wheel loading and reinforced to 0.12-in. sq./ft. Honched concentric cones shall be designed for use with square frames and

grates unless otherwise indicated on the Drawings. Base shall be monolithic construction. Provide precast setting sections "Doughnuts," for frames as shown on the Drawings. Set frames with mortar as covered in paragraph - "Joint Mortar." Acceptable products/manufacturers are:

a. American Concrete Industries.

b. Superior Concrete Co., Inc.

c. c. Approved equal.

2. Gaskets and Connectors: Gaskets for joints between manhole sections shall conform to ASTM C443. Resilient connectors for making joints between manhole and pipes entering manhole shall conform to ASTM C923.

B. Metal Items

1. Frames, Covers, and Gratings: Unless otherwise indicated on the drawings or specified, frames, covers and gratings shall be gray cast iron conforming to ASTM A 48/A 48M -03, Class 30B and suitable for AASHTO H 20-44 and HS 20-44 highway loading.
2. Catch Basins: Unless otherwise indicated on drawings, standard frames and grates shall be provided. Acceptable products/manufacturers shall be:

a. STANDARD: General Foundries 22484-SQH-USA (24” square grate with 8” deep frame) or approved equal;

b. CASCADE: General Foundries 22484-CAS-USA (24” square grate with 8” deep frame) or approved equal;

c. BEEHIVE: Neenah R-2560-E5 (25.75” diameter with 8” deep frame) or approved equal;

d. Or as otherwise specified on drawings.

3. Manholes: Provide non-skid surface with raised letter "DRAIN" designation cast on the cover. Acceptable products/manufacturers shall be:

a. General Foundries Item Number 12681 (25.75” diameter cover with 8” deep frame) or approved equal;

b. Or as otherwise specified on drawings.

4. Drainage Structure Steps: Zinc-coated steel conforming to ANSI A14.3. As an option, plastic or rubber coating pressure-molded to the steel may be used. Plastic coating shall conform to ASTM D4101, copolymer polypropylene. Rubber shall conform to ASTM C443, except shore A durometer hardness shall be 70 plus or minus 5. Aluminum steps or rungs will not be permitted. Provide steps in manholes or catch basins greater than 4 feet deep.

C. Patching Mortar: Provide a hydraulic cement-base, quick-set, mortar at repairable damage sections and pipe openings in catch basins. Provide mortar in conformance with the following:

TEST	RESULT
Compressive Strength (ASTM C109)	20 minutes = 2142-psi
	1-day = 4383-psi
	7-days = 5334-psi
	28-days = 5833-psi
Tensile (ASTM C190)	20-minutes = 210-psi
	1-day = 270-psi
	7-days = 320-psi
	28-days = 370-psi
Flexural (ASTM C348)	7-days = 650-psi
	28-days = 370-psi
Push Out Load	Greater than 6000 psi

1. “Water Plug” by Thoro System Products
2. Approved equal.

D. Joint Mortar: The cement for mortar shall conform to the requirements of Portland cement AASHTO M85, Type II or IIA. Joint mortar shall consist of 1-part Portland cement, 2 parts sand and sufficient water to obtain the required consistency. Mortar shall be used within 30-minutes after its preparation.

E. Cast-in-place concrete applications: refer to section 32 13 13 Site Concrete.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

A. General Requirements for Installation of Pipelines: These requirements shall apply to pipeline installation except where specific exception is made under paragraph entitled "Special Requirements."

1. Location: The work covered by this section shall terminate at a point approximately 10 feet from the building, unless otherwise indicated on the drawings.
2. Earthwork: Perform earthwork operations in accordance with Section 31 21 00, "Earth work for Utilities."
3. Pipe Laying and Jointing: Inspect each pipe and fitting before and after installation; remove those found defective from site and replace with new. Provide proper facilities for lowering sections of pipe into trenches. Lay pipe with the bell ends in the upgrade direction. Adjust spigots in bells to produce a uniform space. Blocking or wedging between bells and spigots will not be permitted. Replace by one of the proper dimensions any pipe or fitting that does not allow sufficient space for proper calking or installation of joint material. At the end of each workday, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose.
4. Connections to Existing Lines: Notify Architect/Engineer in writing at least 10 days prior to date that connections are to be made. Obtain approval of the

Architect/Engineer before interrupting service. Conduct work so that there is minimum interruption of service on existing line.

B. Special Requirements

1. Installation of ABS or PVC Composite Plastic Piping: Install pipe and fittings in accordance with the "General Requirements for Installation of Pipelines" and with the recommendations of the plastic pipe manufacturer. Make joints with the primer and solvent cement specified for this joint; assemble in accordance with the recommendations of the pipe manufacturer. Handle solvent cement in accordance with ASTM F402.
2. Installation of PVC Plastic Piping: Install pipe and fittings in accordance with the "General Requirements for Installation of Pipelines" and with the requirements of UNI B5 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping; assemble in accordance with the requirements of UNI B5 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.
3. Installation of PVC Plastic Piping, Fittings, and Saddles: Install pipe and fittings in accordance with the "General Requirements for Installation of Pipelines" and with the requirements of UNI B5 for laying and jointing pipe and fittings. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer. Make joints with the gaskets specified for joints with this piping; assemble in accordance with the requirements of UNI B5 for assembly of joints and as follows:

    a. Clean all foreign material from bell and rubber ring.

    b. Clean pipe spigot end from all foreign material.

    c. Lubricate spigot end of pipe using pipe manufacturers recommended lubricant. Cover entire spigot end circumference. Coating should be equivalent to one coat of enamel paint. (Keep out of dirt).

    d. Insert spigot end into the bell so that it is in contact with the rubber ring. Keep the pipe lengths in proper alignment.

    e. Follow manufacturer's written installation instructions in strict accordance.

C. Concrete Work: Perform cast-in-place concrete work in accordance with Section 03 30 00, "Cast-In-Place Concrete", and the following:

1. Concrete Cradles (Thrust Blocks): Provide in locations and configurations as indicated on the drawings. Minimum compressive strength of concrete shall be 3000 psi, protect concrete from freezing conditions. Install thrust block from undisturbed soil to mid diameter of the pipes.

    a. Manhole and Catch Basin Construction: Use precast concrete base sections. Make inverts in precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent drainage sections. For precast concrete construction, make joints between sections with the gaskets specified for this purpose; install in the manner specified for installing joints in

concrete piping. Give a smooth finish to inside joints of precast concrete manholes and catch basins. Parging will not be required for precast concrete manholes. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as required to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding beyond into the manhole. Use resilient connectors as specified for pipe connectors to concrete manholes.

D. Metal Work

1. Rims, Frames, Grates, and Covers: Set grating frames in a bed of mortar to grades as indicated on the Drawings. Set all units in strict accordance with the manufacturer's written installation instructions. For additional rim and frame raising conditions set frame on precast risers or "doughnuts."
2. Workmanship and Finish: Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron and steel to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide rabbets, lugs, and brackets wherever necessary for fitting and support.
3. Field Painting: After installation, clean steel covers and steel or concrete frames not buried in masonry or concrete to bare metal of mortar, dirt, grease, and other deleterious materials. Apply a coat of primer, zinc oxide to a minimum dry film thickness of .5-mil; and apply a topcoat, epoxy to a minimum dry film thickness of .5-mils, color optional. Do not paint surfaces subject to abrasion.

3.2 FIELD QUALITY CONTROL

A. Field Tests and Inspections: The Architect/Engineer or representative will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests and provide labor, equipment, and incidentals required for testing, except that the Contractor will furnish water and electric power needed for field tests. Be able to produce evidence, when required, that each item of work has been constructed properly in accordance with the drawings and specifications.

B. Pipeline Testing: Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line.

C. Field Tests for Concrete: Field testing requirements are covered in Section 03 30 00, "Cast-in-Place Concrete”

END OF SECTION 33 41 00

SECTION 33 46 00 - SUBDRAINAGE

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 subdrainage systems for the following:

1. Underslab areas.

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities procedures.
2. Division 01 Section "Temporary Tree and Plant Protection" for protecting trees remaining on-site that are affected by site operations.
3. Division 32 Section "Turf and Grasses, Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
4. Division 31 Section "Earth Moving for Structures and Pavement" for soil materials, excavation and backfilling.
5. Division 31 Section "Earth Moving for Utilities" for soil materials, excavating, backfilling.
6. Division 31 Section "Dewatering" for requirements and guidelines for dewatering procedures.
7. Division 31 Section “Excavation Support and Protection" for requirements and guidelines for dewatering procedures.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Perforated-wall pipe and fittings.
2. Solid-wall pipe and fittings.
3. Geotextile filter fabrics.
4. Clean outs

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to the "Piping Applications" Article in Part 3 for applications of pipe, tube, fitting, and joining materials.

2.3 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PVC Pipe and Fittings:

1. Perforated Polyvinyl Chloride (PVC) Piping: Provide piping in conformance with ASTM D2729. Provide piping in 10-foot lengths. Belled at one end. Provide solid wall PVC pipe sections where drainage is not required, i.e., cleanouts. Provide pipe fittings as follows:

a. 1/4 bend.

b. Fitting cleanout adaptor.

c. 90 - degree long sweep.

d. Threaded plug.

e. Fittings types shall not be limited to stated fittings. Provide fittings as indicated on the drawings and as required for the work. Pipe and pipe fittings shall be supplied/manufactured by one manufacturer. Acceptable products/manufacturers are:

1) “Super Sewer” by Carlon.

2) Approved equal.

B. Slotted PE Pipe and Fittings

1. Slotted dual walled high density polyethylene piping: Provide piping in conformance with ASTM F 405 AND ASTM F606 AND AASHTO M 252 AND AASHTO M 294. Bell and spigot with rubber gasket meeting ASTM F477. Provide solid wall pipe sections where drainage is not required. Provide pipe fittings as follows:

a. 1/4 bend.

b. Fitting cleanout adaptor.

c. 90 - degree long sweep.

d. Threaded plug.

e. Fittings types shall not be limited to stated fittings. Provide fittings as indicated on the drawings and as required for the work. Follow pipe manufacturer’s

recommendations. Pipe and pipe fittings shall be supplied/manufactured by one manufacturer.

f. Basis of Design

1) ADS Inc.

2) Similar as Approved by engineer

2.4 SOLID-WALL PIPES AND FITTINGS

A. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.

1. Gaskets: ASTM F 477, elastomeric seal.

2.5 SPECIAL PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.

1. Sleeve Materials:

a. For Concrete Pipes: ASTM C 443, rubber.

b. For Cast-Iron Soil Pipes: ASTM C 564, rubber.

c. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

d. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant metal tension band and tightening mechanism on each end.
3. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.

B. Copper-Alloy Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing with clamping device; and scoriated, Medium-Duty Loading class, copper-alloy cover. Include countersunk, brass cleanout plug.

C. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

2.7 SOIL MATERIALS

A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

2.8 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

1. Structure Type: Nonwoven, needle-punched continuous filament or woven, monofilament or multifilament.
2. Style(s): Flat and sock.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

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

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 PIPING APPLICATIONS

A. Underground Subdrainage Piping:

1. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Underslab Subdrainage Piping:

1. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.

3.4 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:

1. At Grade in Earth: PVC cleanouts.
2. At Grade in Paved Areas: Cast-iron cleanouts.

B. In Underslab Subdrainage Piping:

1. In Finished Areas: Copper-alloy cleanouts.

3.5 SUB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

E. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

3.6 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
2. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Install PVC piping according to ASTM D 2321.

3.7 PIPE JOINT CONSTRUCTION

A. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

B. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

3.8 CLEANOUT INSTALLATION

A. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.

3.9 FIELD QUALITY CONTROL

A. Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.10 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 33 46 00

SECTION 33 71 19 - ELECTRICAL UNDERGROUND DUCTS, DUCTBANKS, AND MANHOLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Conduit and duct:

1. Galvanized steel rigid metal conduit (RMC).
2. Rigid polyvinyl chloride (PVC) conduit.
3. Polyvinyl chloride (PVC) plastic utilities duct.
4. Reinforced thermosetting resin conduit (RTRC).

B. Precast concrete manholes.

C. Accessories:

1. Underground warning tape.

1.2 RELATED REQUIREMENTS

A. Section 03 10 00 - Concrete Forming and Accessories.

B. Section 03 20 00 - Concrete Reinforcing.

C. Section 03 30 00 - Cast-in-Place Concrete.

D. Section 07 11 13 - Bituminous Dampproofing.

E. Section 31 23 16 - Excavation.

F. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

G. Section 31 23 23 - Fill: Bedding and backfilling.

H. Section 33 05 69 - Concrete Trenchways: For routing of electrical utilities.

1.3 PRICE AND PAYMENT PROCEDURES

A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

B. Ductbank:

1. Basis of Payment: Includes purchase, delivery, and installation of duct, fittings, supports, and accessories, and for trenching, concrete encasement, and backfill.

C. Manhole:

1. Basis of Measurement: Per unit.
2. Basis of Payment: Includes purchase, delivery, and installation of manhole.

1.4 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.

B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

C. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures; 2019.

D. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures; 2019.

E. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures; 2020.

F. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures; 2016 (Reapproved 2024).

G. ASTM D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal); 2010 (Reapproved 2019).

H. ASTM D1598 - Standard Test Methods for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure; 2024.

I. ASTM D1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings; 2018 (Reapproved 2024).

J. ASTM F512 - Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation; 2025 .

K. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.

L. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

M. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

N. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

O. NEMA BI 50063 - Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations; 2025.

P. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation; 2020.

Q. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

R. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

S. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

T. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

U. UL 746C - Polymeric Materials – Use in Electrical Equipment Evaluations; Current Edition, Including All Revisions.

V. UL 2420 - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Current Edition, Including All Revisions.

W. UL 2515 - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Current Edition, Including All Revisions.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for metallic conduit, nonmetallic conduit, and manhole accessories.

C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles (160 km) of Project.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 CONDUIT AND DUCT

A. Galvanized Steel Rigid Metal Conduit (RMC): NFPA 70, Type RMC; comply with ANSI C80.1 and list and label as complying with UL 6.

1. Manufacturers:

a. Allied Tube & Conduit; _____: www.alliedeg.com/#sle.

b. Republic Conduit; _____: www.republic-conduit.com/#sle.

c. Wheatland Tube, a Division of Zekelman Industries; _____: www.wheatland.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Fittings: Comply with NEMA FB 1 and list and label as complying with UL 514B; steel or malleable iron, threaded type.

    a. Manufacturers:

        1) Bridgeport Fittings Inc; _____: www.bptfittings.com/#sle.

        2) O-Z/Gedney, a brand of Emerson Electric Co; _____: www.emerson.com/#sle.

        3) Thomas & Betts Corporation; _____: www.tnb.com/#sle.

        4) Substitutions: See Section 01 60 00 - Product Requirements.

B. Rigid Polyvinyl Chloride (PVC) Conduit: NFPA 70, Type PVC; comply with NEMA TC 2 and list and label as complying with UL 651; Schedule 40 unless otherwise indicated; rated for use with conductors rated 90 degrees C.

1. Manufacturers:

    a. Cantex Inc; _____: www.cantexinc.com/#sle.

    b. Carlon, a brand of Thomas & Betts Corporation; _____: www.carlon.com/#sle.

    c. JM Eagle; _____: www.jmeagle.com/#sle.

    d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Fittings: Comply with NEMA TC 3 and list and label as complying with UL 651.

    a. Manufacturer: Same as manufacturer of conduit to be connected.

C. Polyvinyl Chloride (PVC) Plastic Utilities Duct: Comply with NEMA BI 50063 and ASTM F512; Type EB-20 listed and labeled as complying with UL 651 suitable for burial with concrete encasement.

1. Manufacturers:

    a. Cantex Inc; _____: www.cantexinc.com/#sle.

    b. Carlon, a brand of Thomas & Betts Corporation; _____: www.carlon.com/#sle.

    c. JM Eagle; _____: www.jmeagle.com/#sle.

    d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Fittings: Comply with NEMA TC 9.

    a. Manufacturer: Same as manufacturer of duct to be connected.

D. Reinforced Thermosetting Resin Conduit (RTRC) and Fittings: NFPA 70, Type RTRC; list and label as complying with UL 2420 or UL 2515.

1. Manufacturers:

a. Champion Fiberglass, Inc; _____: www.championfiberglass.com/#sle.

b. FRE Composites USA, Inc; _____: www.frecomposites.com/#sle.

c. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PRECAST CONCRETE MANHOLES

A. Manufacturers:

1. _____.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Precast manhole designed in accordance with ASTM C858, comprising modular, interlocking sections complete with accessories.

C. Loading: ASTM C857, Class A-16.

D. Shape: As indicated.

E. Nominal Inside Dimensions: ____ feet (____ mm) x ____ feet (____ mm).

F. Inside Depth: ____ feet (____ mm).

G. Wall Thickness: ____ inches (____ mm).

H. Base Section: Include 3 inch (75 mm) deep x 14 inch (350 mm) round sump with cast sleeve, and two 1 inch (25 mm) ground rod openings.

I. Top Section: Include 39 inch (1000 mm) diameter grooved opening for frame and cover.

J. Riser Casting: 6 inch (150 mm), with manhole step cast into frame.

K. Frames and Covers: ASTM A48/A48M; Class 30B gray cast iron, 27 inch (686 mm) size, machine finished with flat bearing surfaces. Provide cover marked ELECTRIC to indicate utility.

L. Duct Entry Provisions: Window knockouts.

M. Duct Entry Locations: ____ each end.

N. Duct Entry Size: 6 inch (150 mm).

O. Cable Pulling Irons: Use galvanized rod and hardware. Locate opposite each duct entry. Provide watertight seal.

P. Cable Rack Inserts: Minimum load rating of 800 pounds (365 kg). Locate at ____ feet (____ m) on center.

Q. Cable Rack Mounting Channel: 1-1/2 x 3/4 inch (38 x 19 mm) steel channel, 48 inch (1.2 mm) length. Provide cable rack arm mounting slots on 1-1/2 inch (38 mm) centers.

R. Cable Racks: Steel channel, 1-1/2 x 3/4 x 14 inches (38 x 19 x 350 mm), with fastener to match mounting channel.

S. Cable Supports: Porcelain clamps and saddles.

2.3 ACCESSORIES

A. Adhesive for HDPE Conduit and RTRC:

1. Specifically designed for bonding dissimilar materials in lieu of transition fittings, including but not limited to polyethylene, fiberglass, PVC, aluminum, and steel; UL 746C recognized.
2. Approved by adhesive manufacturer for use with materials to be joined.
3. Adhesive Shear Strength: Not less that 100 psi (720 kPa), when tested in accordance with ASTM D1002.
4. Hydrostatic Pressure Resistance: No leaks, when tested in accordance with ASTM D1598 at 120 psi (830 kPa) for 1,000 hours and when tested in accordance with ASTM D1599 at 250 psi (1700 kPa).
5. Products:

a. American Polywater Corporation; Polywater BonDuit Conduit Adhesive: www.polywater.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

B. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for the conduit/duct arrangement to be installed.

1. Products:

a. Advance Products & Systems, LLC; Duct Bank Spacers: www.apsonline.com/#sle.

b. Substitutions: See Section 01 60 00 - Product Requirements.

C. Underground Warning Tape: Polyethylene tape suitable for direct burial.

1. Manufacturers:

a. Brady Corporation; _____: www.bradyid.com/#sle.

b. Brimar Industries, Inc; _____: www.brimar.com/#sle.

c. Seton Identification Products; _____: www.seton.com/#sle.

d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Foil-backed Detectable Type Tape: 6 inches (152 mm) wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.
3. Legend: Type of service, continuously repeated over full length of tape.
4. Color:

a. Tape for Buried Power Lines: Black text on red background.

b. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.4 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Precast Manholes: Inspect in accordance with ASTM C1037.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

C. Verify locations of manholes prior to excavating for installation.

D. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.

E. Manhole locations are shown in approximate locations unless dimensions are indicated. Locate as required to complete ductbank system.

3.2 DUCT BANK INSTALLATION

A. Install duct to locate top of ductbank at depths as indicated on drawings.

B. Install power and communications duct to locate top of ductbank minimum 30 inches (____ mm) below finished grade.

C. Install duct with minimum slope of 4 inches per 100 feet (100 mm per 25.4 m) (0.33 percent). Slope duct away from building entrances.

D. Cut duct square using saw or pipe cutter; de-burr cut ends.

E. Insert duct to shoulder of fittings; fasten securely.

F. Join nonmetallic duct using adhesive as recommended by manufacturer.

G. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

H. Install no more than equivalent of three 90-degree bends between pull points.

I. Provide suitable fittings to accommodate expansion and deflection where required.

J. Terminate duct at manhole entries using end bell.

K. Stagger duct joints vertically in concrete encasement 6 inches (150 mm) minimum.

L. Use suitable separators and chairs installed not greater than 4 feet (1200 mm) on centers.

M. Band ducts together before backfilling.

N. Securely anchor duct to prevent movement during concrete placement.

O. Place concrete under provisions of Section 03 30 00. Use mineral pigment to color concrete red.

P. Provide minimum 3 inch (75 mm) concrete cover at bottom, top, and sides of ductbank.

Q. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.

R. Connect to existing concrete encasement using dowels.

S. Connect to manhole wall using dowels.

T. Provide suitable pull string in each empty duct except sleeves and nipples.

U. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

V. Interface installation of underground warning tape with backfilling. Install tape 12 inches (____ mm) below finished surface.

3.3 PRE-CAST MANHOLE INSTALLATION

A. Excavate for manhole installation under the provisions of Section 31 23 16.

B. Install and seal precast sections in accordance with ASTM C891.

C. Install manholes plumb.

D. Use precast neck and shaft sections to bring manhole cover to finished elevation.

E. Attach cable racks to inserts after manhole installation is complete.

F. Install drains in manholes and connect to site drainage system.

G. Install drains in manholes and connect to 4 inch (DN100) pipe terminating in 1/3 cu yd (1/4 cu m) crushed gravel bed. .

H. Dampproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days, under provisions of Section 07 11 13.

I. Backfill manhole excavation under the provisions of Section 31 23 23.

END OF SECTION 33 71 19