BID DOCUMENTS COVER SHEET

CONTRACT DOCUMENTS

FOR

L-636 Physical Education & Student Union Complex

AT

LOS MEDANOS COLLEGE

2700 East Leland Road,
Pittsburg, California 94565

CONTRA COSTA COMMUNITY COLLEGE DISTRICT

Consist of the following:

DSA File #7-C1
DSA Application # 01-115488

Volume 02 - Divisions 21-33

Architect: LPA
60 South Market Street,
Suite 150 San Jose, CA 95113

May 8, 2017
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**DIVISION 34 TO 35**.......................... NOT USED

**PROCESS EQUIPMENT SUBGROUP**

**DIVISIONS 40 TO 45, & 48**.......................... NOT USED

**DRAWINGS PREPARED BY LPA INC.**

END OF TABLE
AUTOMATIC SPRINKLER SYSTEM

PART 1 – GENERAL

1.01 GENERAL DESCRIPTION

A. Furnish all materials and labor for the detailed design and installation for a new fire sprinkler (wet-pipe) system, hereafter referred to as the “System” in compliance with this Specification.

B. The contract drawings and this Specification define the scope of work for the project. The contract drawings are intended to be engineered working plans only in accordance with NFPA 13 Chapter 23 and the DSA AFSS Guidelines and the Contractor’s responsibilities are defined herein. Where conflicts occur between the Specification and the contract drawings, the bidder is instructed to request clarification prior to bidding. In general, should a conflict occur, it is the Contractor’s responsibility to request verification prior to bidding.

C. The work shall be subject to the terms and conditions contained in the Construction Contract agreement between the Contractor and the Architect/Owner/District.

D. All applicable fees, taxes, and permit costs for all work contained in this specification section shall be included in the Contractor’s base bid.

E. Contractor shall be responsible for the review and compliance with this Specification section and the DSA approved plans and calculations. All work shall be performed in accordance with these Specifications and good engineering and installation practice. Modifications to these Specifications will NOT be accepted without the expressed written approval of Architect/Owner, Architect/Owner’s Representative and/or Architect/Owner’s insurance carrier; herein referred to as the “Architect/Owner”. It is the Contractor’s responsibility to document the required approvals of any such modifications prior to the execution of work. It is the Contractor’s responsibility to document the intent to modify the approved design and document all required approvals of any such modifications deemed “major changes” based on DSA Policy PL 10-01, Section 4.3.1 prior to bid and prior to the execution of work. Change of the design by the contractor as outlined in Section 4.3.1
will NOT be accepted without the express written approval and coordination with the Architect/Owner.

F. It is the Contractor’s responsibility to receive approval of any changes from the design drawings deemed “minor changes” as outlined in Section 4.3.2 of DSA Policy PL 10-01 using the DSA change order process and appropriate addenda. For changes to the design drawings which alter the design of the system and require a Field Change Document (FCD) to be prepared, the preparation of the FCD shall be the responsibility of the Contractor and review will be provided by The Engineer of Record. Changes or modifications which do not modify the design of the system (such as addition of bracing or changes in specified material) shall be addressed using a DSA change order and shall require approval of the Architect/Owner.

G. Contractor shall field verify all site conditions and information contained on the contract drawings and is responsible for the complete design and installation of the system in accordance with the specifications. The contract drawings may not show all information necessary for installation of the system, but are intended to be used by Contractor for the purpose of preparing a bid. The contract drawings indicate the following:
1. Hydraulically calculated pipe routing and sizes.
2. Types and minimum quantities of sprinklers and valves within the building.
3. Location of the new riser for the System and major points on the system.
4. NFPA Hazard Classifications
5. Seismic bracing calculations and attachment locations
6. Hanger locations
7. Building sections
8. System details
9. Additional information as required in the DSA AFSS Checklist.
10. There shall be no impairments to any of the adjoining building system in any way due to the work provided for in this Specification.

1.02 INTENT OF SPECIFICATIONS

A. The work performed pursuant to the Specifications is to be complete in every respect, resulting in the System installed in accordance with the applicable codes, standards, manufacturers’ recommendations and Underwriters Laboratories Inc. (UL) Listings and/or Factory Mutual (FM) Global approval.

B. Upon completion of this work and as a part of this Contract, Contractor shall provide Architect/Owner with:
1. Complete information and ‘as-built’ record drawings describing and depicting the entire system as installed, including all
information necessary for maintaining, troubleshooting, and/or expanding the system at a future date.

2. Complete documentation of the system testing and Authority Having Jurisdiction (AHJ) acceptance.

C. Certification that Contractor's work has been inspected and tested is installed entirely in accordance with the applicable codes, standards, manufacturers’ recommendations and UL listings and/or FM approvals and is in proper working order. Contractor shall use “Contractor’s Material and Test Certificate (s)” as required by NFPA codes.

1.03 WORK INCLUDED

A. General: Furnish all materials and labor for the design, installation, and testing of the new sprinkler system throughout the new building in accordance with all applicable codes and requirements of this Specification throughout the New Classroom Building.

B. Provide personnel to inspect and verify piping and sprinkler locations as indicated in the bid drawings. The Contractor is responsible for any pipe routing changes, including offsets, required to install the new system. Design changes must be approved by DSA.

C. Sprinkler: Furnish and install all components necessary for the automatic sprinkler system to result in a fully operational system. Provide appropriate water flow (pressure switch or vane type) and valve supervisory (tamper) to provide all monitoring of the System. Interface to the new fire alarm system shall be completed by the Fire Alarm Contractor as specified in the Fire Alarm Specification.

D. Sprinkler Zones: Where shown on the drawings and/or detailed in the specifications, fire sprinkler system zoning and alarms shall correspond to alarm and detection and/or smoke control zones at a minimum, one sprinkler zone is required for each full floor.

E. Water supply for the building will be served from the existing campus loop served from the existing water mains.

F. Drains: Drains shall terminate at the exterior of the building or when and where approved by Architect/Owner, at an interior drain capable of handling full flow conditions.

G. Provide updated record (as-built) drawings and hydraulic calculations to the Architect/Owner’s Consultant for final approval. Also, provide updated hydraulic calculations, particularly if the construction condition deviates from the approved design. Changes must be reviewed and approved by DSA.

H. Shields: Install shields where necessary to protect electrical equipment from sprinkler discharge. Shields shall be such that water spray from sprinklers is shielded from the intended equipment only. Shields shall not completely block water spray over the remainder of
the area to be protected. Coordinate with electrical drawings for these locations.

I. Valves: Furnish and install all system control valves, main and inspector's test drain valves and other appurtenances as required for a fully operable system. All system control valves shall be equipped with tamper switches for electronic supervision.

J. Painting: Painting of pipe and fittings shall be included throughout the building where the piping and fittings are exposed in public areas. The Contractor must coordinate with the Architect/Owner regarding color matching and adjacent architectural features. The Contractor shall include one coat of latex primer and one finished coat of latex paint. Pipe and fittings shall be painted red in mechanical and non-public areas (unless otherwise indicated on building plans or as directed by Architect/Owner) to indicate fire service use.

K. Submittals: Prepare and submit shop drawings, product data sheets, hydraulic calculations, record drawings and other submittals required herein. Work is not to proceed until all required submittals have been approved by Architect/Owner and all AHJ (if shop drawings differ from the DSA approved design). Contractor shall be responsible for the submission of the required materials to the Architect/Owner. If the shop drawings deviate from the approved design, the Contractor is responsible for resubmission to DSA.

L. Tests: Each new sprinkler system shall be tested in accordance with the requirements of NFPA 13, AHJ and the Architect/Owner. The Sprinkler contractor shall also attend all fire alarm tests to aid in testing sprinkler system monitoring devices. Contractor shall be responsible for carrying out all required tests. Separate tests may be required by the Architect/Owner and AHJ.

M. Approvals: Obtain all approvals required for the work of this Section from all AHJ and Architect/Owner.

N. Fees: Pay all fees required to obtain permits, inspections and final approval of the work in this Section.

O. Coordination: Coordinate work with all other trades working on the project and with the other fire protection system specified elsewhere.

P. Unit Additions: Contractor shall provide unit pricing for any additional work or services.

1.04 RELATED WORK SPECIFIED ELSEWHERE

A. Underground Water Supply Piping: Water supply piping to a one piece stainless steel riser with dielectric flange left plumb and level, six (6) inches above the finished floor at points shown on the bid drawings and documents. Size of flanges and underground supply
mains are as shown. Project point of connection shall be 5'-0” outside the building line.

B. Alarms: Wiring and connection to the sprinkler system alarm and supervisory devices shall be provided by Fire Alarm and Detection Contractor as detailed in the Fire Alarm and Detection Specification.

C. Drains: Floor drains and other facilities for receiving discharge from sprinkler system drains.

1.05 QUALITY ASSURANCE

A. All work shall conform to the requirements of the applicable editions and portions of the NFPA Standards, locally adopted codes, including:
   1. Title 24, Part 2, California Building Code (CBC) 2013 edition
   2. Title 24, Part 3, California Electrical Code (CEC) 2013 edition
   3. Title 24, Part 9, California Fire Code (CFC) 2013 edition

B. Code Conflicts: Should conflicts exist between the referenced NFPA Standards, Federal, State or local codes and this Specification, it shall be Contractor's responsibility to bring the conflict to the attention of Architect/Owner for resolution. The Contractor shall not attempt to resolve code conflicts with the local authority, independent of Architect/Owner. In general, in the event of a conflict, the most stringent of the requirements will apply.

C. Permit Fees: Contractor shall be responsible for filing all documents, paying all fees and securing all permits, inspections and approvals necessary for completing the scope of the work in this Section.

D. Equipment: All devices, systems, equipment and materials furnished and installed shall be new and shall be submitted for approval by Architect/Owner. All sprinklers, pipe, fittings, hangers, valves, and other materials and equipment shall be UL listed and/or FM approved for their intended use. All shall be acceptable to the AHJ when such agencies have listings of acceptable equipment.

E. Fittings: Fittings may be of the flanged, threaded, or grooved type. Welded outlets on cross-mains for riser nipples and/or branch lines and for sprinkler outlets on branch lines will be permitted. All shall be UL listed and/or FM approved for their intended use. The use of plain-end fittings to join steel pipe is not permitted.

F. Contractor Requirements: Contractor shall:
   1. Hold all licenses and obtain all permits necessary to perform work of this type in the state of California. Copies of Contractor's licenses shall be provided with bid submittal.
2. Be regularly engaged for the past five years in the design, installation, testing and servicing of automatic sprinkler systems for buildings of this type.
3. Contractor's site supervisor will be at the jobsite at all times when work is actively in progress.

1.06 SPRINKLER SYSTEM DESIGN CRITERIA

A. Densities: Hydraulically designed and calculated sprinkler system shall be installed in accordance with the construction documents. The System has been designed to produce discharge densities of:
4. 0.10 gpm/square foot over the hydraulically most remote 1,500 square feet in spaces designated as Light Hazard occupancies.
5. 0.15 gpm/square foot over the hydraulically most remote 1500 square feet in spaces designated as Ordinary Hazard Group I occupancies.
6. 0.20 gpm/square foot over the hydraulically remote 1500 square feet in spaces designated as Ordinary Hazard Group II occupancies.

B. Hose stream requirements: The calculations shall include a 100 gpm inside hose stream at the hose valve closest to the floor control valve assembly. The combined (inside and outside) hose stream for the calculations shall be 250 gpm.

C. Provide sprinklers throughout the facility including under ducts, stairs, and obstructions as required by NFPA 13. Additional sprinklers under ducts, stairs, or other obstructions wider than 4 feet required but not shown on the construction documents in excess of 15 shall be provided at the unit additional cost specified by the Contractor in the bid format sheets. Base bid shall include 15 sprinklers in additions to those indicated in the drawing.

D. All branch line piping shall be minimum 1” nominal size. Branch line piping in gridded systems shall be minimum 1¼” nominal size. Threaded outlets on branch lines supplying sprinklers shall match the sprinkler threads, but shall be 1” NPT if supplying a sprig or drop.

1.07 SUBMITTALS

A. Shop Drawings: Contractor will be authorized to start the project or portions of the project when the shop drawings for the work are received, reviewed and approved by the design team. Installation prior to these approvals shall be at the Contractor’s risk.
1. Shop drawings shall show all of the information required by the applicable NFPA codes for working plans. Where the shop drawings depict changes from the approved design, the drawings shall also include the information outlined in DSA AFSS Submittal Guidelines for resubmission to DSA.
2. Shop drawings shall include a drawing legend sheet identifying:
   a. All symbols used on the drawings by type of device or equipment, manufacturer and manufacturer’s part number.
This information shall correspond to the manufacturer's catalog data sheets and installation manuals.

b. All conventions, abbreviations, and specialized terminology used on the drawings, as necessary to understand and interpret the information contained therein.

c. A complete drawing list identifying all drawings in the shop drawing package by title, drawing number, and specification cross reference.

3. Shop drawings shall be single line or architectural floor plan drawings, drawn to 1/8 inch equals one foot scale or larger (i.e., ¼-inch, etc.) showing a key plan and all other information required by the applicable NFPA codes for shop drawings.

B. Product Data: Contractor shall submit a product data submittal with the shop drawings. Manufacturers' Data Sheets shall show the type and model of all equipment or material proposed. This information shall include type of pipe, hangers, valves, pipe fittings/joining methods, air compressors, releasing panels, detection equipment, sprinklers, water flow devices, supervisory devices, Fire Department Connections, escutcheons, and signage. When a Data Sheet shows more than one product, the specific proposed product shall be clearly indicated by arrows or other suitable means. All manufacturers' data sheets shall clearly show all UL listings and/or FM approvals for each product submitted.

C. Contractor shall provide hydraulic calculations in accordance with the requirements of NFPA 13, showing that the pipe sizes provided will produce adequate performance where the Contractor's design deviates from that approved by DSA. A minimum safety factor of 10 psi or 10%, whichever is greater of the available pressure at the required system flow (including all required hose stream demands) shall be demonstrated in the hydraulic calculations.

D. Two sets of shop drawings, product data sheets, and hydraulic calculations as described in parts A, B, and C shall be submitted to Architect/Owner for review. Only complete submittals containing all required information for all work required in this Section will be reviewed. Incomplete submittals will be returned to Contractor without being reviewed.

E. All drawings and diagrams shall be prepared on drawing sheets of uniform size, 30 by 42 inches minimum and shall contain no extraneous information. Marked up electrical, HVAC or similar drawings or copies of catalog data sheets are not acceptable in lieu of the required drawings or diagrams. All other information required for this submittal shall be submitted in one or more appropriately labeled (i.e., Contractor's name, project, submittal name/description and date) and indexed in 3-ring binders.

F. All drawings and diagrams shall include Contractor's title block, complete with drawing title, Contractor's name, address, date
including revisions, and preparer’s and reviewers initials. All drawings and diagrams shall be reviewed and stamped as required by the AHJ.

G. Samples: Within 30 days of authorization to proceed, Contractor shall submit to Architect/Owner for approval, samples of all types of proposed sprinklers, including types of finishes available and a complete list of where each type and finish will be installed.

H. Prior to start of installation, Contractor shall submit copies of all permits and approvals to Architect/Owner necessary to conduct this work. A minimum of one complete set of such permits and approvals shall be kept by Contractor at the jobsite and shall be available for review.

I. Contractor shall provide Architect/Owner with one copy of all documents that are reviewed and approved by the AHJ and/or local code authorities. These documents shall include, but not be limited to the following:
1. Site inspection forms
2. Shop drawings
3. Final inspection forms
4. Workers’ Compensation insurance

All documents shall include all required approval stamps, signatures or other information necessary to properly certify that the installation has been reviewed and accepted by the AHJ.

J. Operation and Maintenance (O&M) Manual: The Contractor shall provide Architect/Owner with an indexed 3-ring binder containing:
1. 11”x17” reduced copies of the ‘as-built’ record drawings required below (Final submittal only)
2. Manufacturers’ catalog data sheets and installation manuals
3. Copies of all test certificates and approvals
4. A list of recommended spare parts and summary of spare parts provided
5. A service directory, including a list of Contractor’s contact names and telephone numbers for service on the system, including emergency service as required elsewhere in these Specifications.

K. Draft O&M Manual: Within 30 days following the notice of authorization to proceed, Contractor shall submit to Architect/Owner three copies of the draft manual for approval, excluding test certificates and drawings. The draft manual will be reviewed for required content and approved or disapproved on that basis. Upon completion of the project, Contractor shall revise the approved preliminary manual to reflect the system as installed and to coordinate the testing and maintenance schedule with the approved Contractor testing protocols. Any and all assigned fire protection device numbers shall also be indicated on the Contractor’s record drawings.
L. Final O&M Manual: Within 30 days of the completion of the work, two final copies of the approved manual with reduced drawings and test certificates shall be delivered to the Architect/Owner.

M. Record Drawings: Contractor shall provide and maintain on the site an up-to-date ‘as-built’ record set of approved shop drawing prints which shall be marked to show each and every change made to the sprinkler system from the original approved shop drawings. This requirement shall not be construed as authorization to deviate from or make changes to the shop drawings approved by Architect/Owner without written instruction from Architect/Owner in each case. These drawings shall be maintained in a current condition at all times and shall be made available for review immediately upon request during normal working hours throughout the installation.

N. Upon completion of the ‘as-built’ record drawings and before final approval, one set of reproducible ‘as-built’ record drawings shall be delivered to Architect/Owner. Upon approval by Architect/Owner, two sets of final record drawing shall be furnished to Architect/Owner. In addition, a record set of drawings shall be transmitted to Architect/Owner in the latest version of AutoCAD electronic format with any applicable executable, unarchiving files.

O. If Contractor's submittals, upon review by Architect/Owner, do not conform to the requirements of these specifications, Contractor shall be required to resubmit with modifications, within ten (10) working days of receipt of Architect/Owner's notification to Contractor. Contractor shall be responsible for Architect/Owner's expenses for subsequent review of rejected submittals that were necessitated by Contractor's failure to make the requested modifications. Such extra fees shall be deducted from payments by Architect/Owner to Contractor.

1.08 WARRANTY AND EMERGENCY SERVICE.

A. Contractor shall warrantee all materials and workmanship for a period of one (1) year beginning with the date of final acceptance of Contractor's completed installation by Architect/Owner. Contractor shall be responsible during the design, installation, testing, and warranty periods for any damage caused by Contractor (or its subcontractors) or by defects in Contractor's (or its subcontractors) work, materials, or equipment.

B. Emergency Service: During the installation and warranty period, Contractor shall provide emergency repair service for the sprinkler system within four (4) hours of a request by Architect/Owner for such service. This service shall be provided on a 24-hour per day, seven days per week basis.
1.09 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts and special tools shall be provided to Architect/Owner prior to final acceptance and shall be provided for each system riser location.

B. Spare Parts: Contractor shall install UL listed and/or FM approved spare sprinkler cabinets containing a minimum quantity of sprinklers of each type, finish and temperature rating used in accordance with the requirements of NFPA 13, but not less than six (6) spare sprinklers. Contractor shall provide two (2) sets of sprinkler wrenches compatible with each type of sprinkler provided in each cabinet. The cabinets shall be installed near the system riser at a location approved by Architect/Owner. Contractor shall provide as many sprinkler cabinets as necessary to accommodate the required number of spare sprinklers, but a minimum of one spare cabinet per sprinkler riser location shall be provided.

C. Special Tools: Contractor shall supply Architect/Owner with two complete sets of special tools and equipment necessary to perform routine maintenance on the sprinkler systems.

1.10 FINAL ACCEPTANCE

A. Date of Final Acceptance will be established by Architect/Owner and shall be based on acceptance of the installation and required approved documentation by Architect/Owner and AHJ.

1.11 ADDITIONAL WORK

A. Provide sprinklers throughout the facility including under ducts, stairs, and obstructions as required by NFPA 13. An allowance for sprinklers under ducts, stairs, or other obstructions wider than 4 feet, required by NFPA 13 but not shown on the construction documents, shall be provided at the unit additional cost specified by the Contractor in the bid format sheets. Base bid shall include an allowance for 15 sprinklers in addition to those indicated in the drawing.

B. Prior to the award of the Automatic Fire Sprinkler system contract, the contractor shall provide the owner with unit pricing and/or allowances for additional work that may be required beyond the scope of work shown on the contract documents to meet NFPA and CBC requirements. If unit pricing and/or allowances are not provided, the installing contractor shall not be reimbursed for additional work provided.

PART 2 – PRODUCTS

2.01 GENERAL

A. All equipment and system components furnished and installed shall be new and of first quality and be UL listed and/or FM approved for their intended use. All such equipment and system components shall be installed in accordance with the respective UL listings, FM
approvals and California State Fire Marshal approved. All materials shall be acceptable to the Architect/Owner and the AHJ.

2.02 PIPE AND FITTINGS - GENERAL

A. Pressure ratings: Pressure ratings of all fittings shall meet or exceed maximum working pressures available within the system.

B. Corrosion protection: All piping and hangers, where exposed to the weather or installed in a corrosive atmosphere shall be protected against corrosion. Piping and hangers in such areas shall be stainless steel and/or hot dipped galvanized. Piping having an external only galvanized finish in such areas is not acceptable.

2.03 ABOVEGROUND PIPING COMPONENTS

A. Pipe Sizes 2.5 inches (65mm) and larger:
   1. Piping shall be ASTM A-53/A - 135/A-795, Weight Class STD (Standard), Schedule 40 (except for Schedule 30 for pipe sizes 8 inches (200 mm) and greater in diameter), Type E or Type S, Grade A; black steel pipe. Steel pipe shall be joined by means of flanges welded or screwed to the pipe, threaded fittings or grooved couplings only. Piping shall not be joined by welding or weld fittings.
   2. Thinwall Pipe: Schedule 10 Pipe meeting ASTM A-53, A-135 or A-795 requirements with grooved pipe couplings and fittings. Grooves in Schedule 10 pipe shall be rolled groove only. Pipe having wall thicknesses less than Schedule 10 is not acceptable.

B. Piping Sizes 2 inches (50 mm) and Smaller
   1. Steel Pipe: Steel piping shall be ASTM A-53/A – 135/A-795, Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A, steel pipe with threaded end connections. Fittings shall be ASME B16.39, Class 150, cast or ductile iron threaded fittings. Unions shall be ASME B16.39, Class 150 unions. Pipe may also be joined using grooved couplings and fittings. Where grooved joining is used, cut or rolled grooves are acceptable.
   2. Post-chlorinated Poly Vinyl Chloride (CPVC) shall not be acceptable.

C. Pipe Hangers and Supports
   1. Pipe hangers and supports shall be UL listed, FM approved, and California State Fire Marshal approved for fire protection use and shall be installed in accordance with their listings and manufacturers’ recommendations. Type, quantity, and spacing shall be in accordance with the requirements for the specific seismic zone requirements and those of NFPA.

2.04 CONTROL AND DRAIN VALVES

A. Sprinkler system control and drain valves shall be the following types:
   1. OS&Y, gate valves
2. Post indicator valves shall be direct buried, made of cast iron body, resilient wedge construction, fusion epoxy lined and coated, non-rising stem with cast iron body, adjustable type and conforming to AWWA specifications. Post indicator shall be cast iron body, adjustable type, and include non-breakable plastic windows to indicate the valve position. A Post indicator valve shall have a operating wrench attached to the post indicator. Valves are to be locked in the open position.


4. Brass seated, straight-way or angle globe valves for main drain and inspector's test. System Gauges shall be riser mounted to ¼ inch, three-way globe valves.

5. Riser check valve: A riser check valve shall be provided on the building water supply riser, prior to the Fire Department Connection. The riser check valve shall have a cast iron body and shall be of the “swing check” type/style. Wafer type check valves will not be permitted.

B. Access Panels: Furnish and install access panels (minimum size 12 inches by 12 inches) for all control valves located above finished ceilings or concealed in walls. Architect/Owner will select finish of access panels. Access panels installed in fire resistive construction shall be of the types required for maintaining proper protection of assembly.

C. Valves and assemblies that are exposed to potential damage by vehicles or other traffic are to be protected by providing a cage or other approved barrier when located inside the building.

2.05 ELECTRICAL WORK

A. Furnish all labor, equipment and services necessary for the design and installation of required connections as required to complete fully operational system. Contractor will be responsible for the mounting of all water flow, tamper, and pressure switches for the fire protection systems in this Section. Ring of such devices is outside the scope of this Specification. Wiring of such devices is included in the Alarm and Detection Specification and is the responsibility of the Fire Alarm contractor.

B. Service: Confirm power connections with electrical contractor.

D. Testing: Provide the required assistance to the Alarm and Detection Contractor to test, adjust and place the fire protection system into initial operation.
2.06 SPRINKLERS

A. Contractor shall furnish and install fire sprinklers of the following types and finishes.
   1. Concealed Quick-Response pendent sprinklers shall be installed in all public areas. Concealed sprinklers shall be UL listed or FM approved assembly. Concealed plate finish shall be factory painted to match the ceiling on which it is installed unless otherwise directed by the Architect/Owner in the submittal process.
   2. Quick-Response sidewall sprinklers shall be installed in the elevator pit where combustible hydraulic fluid is present. Sidewall sprinklers shall be UL listed or FM approved assembly and the escutcheon shall be integral to the sprinkler. Finish shall be brass for the sprinkler and escutcheon unless otherwise directed by the Architect/Owner in the submittal process.
   3. Quick-Response upright or pendent sprinklers shall be installed in non-public, unfinished areas. Sprinkler finish shall be brass unless otherwise directed by the Architect/Owner in the submittal process.
   4. Quick-Response upright or pendent with cage guards, shall be installed in areas subject to damage (e.g., under stairs and mechanical rooms). Fusible link style sprinklers shall be acceptable in areas subject to damage. Sprinkler finish in such areas shall be brass, unless otherwise directed by the Architect/Owner in the submittal process.

B. Window sprinklers shall be installed to protect glazed openings in fire rated walls. Final Selection: Architect/Owner will select finishes for all automatic sprinklers and escutcheons.

C. Uniformity: All sprinklers within a space shall be from the same manufacturer and shall have the same type and style of heat response element, including temperature rating and response characteristics.

D. Temperature Rating: It shall be Contractor’s responsibility to install sprinklers of the proper temperature rating as required by NFPA 13.

E. Corrosion Resistance: Sprinklers located on exterior piping systems or in areas exposed to corrosive atmospheres shall be UL listed and/or FM approved corrosion resistant coated or stainless steel.

F. Penetrations through the ceiling for sprinklers that are not integrally tied to the ceiling system in the lateral direction shall have a two (2) inch oversized ring, escutcheon, or cover plate through the ceiling tile to allow free movement of one (1) inch in all horizontal directions per ASTM E580.

G. Sprinkler Orifice: Sprinkler orifice sizes shall be confirmed through hydraulic calculations for the system. Sprinklers having a nominal “K” factor of less than 5.6 are not acceptable unless specifically allowed by NFPA 13. The orifice size shall be uniform within a protected area.
H. All sprinklers in finished areas shall be center of tile plus or minus 1 inch, unless approved by the Architect/Owner. All sprinklers shall be aligned in all directions when multiple sprinklers are in the same area and are in the same line of sight. Contractor shall coordinate location of all sprinklers in finished areas with Architect/Owner. Where acceptable to AHJ, the use of flexible drops is permitted, but all such drops must be installed in accordance with their UL listings and/or FM approvals. Where such listings/approvals differ, the most stringent installation requirements will apply. The use of flexible drops shall be accounted for in all hydraulic calculations for the system. Flexible drops shall be of the braided, stainless steel hose style. Flexible drops employing corrugated steel tubing will not be permitted.

I. Sprinkler Escutcheons: Flush sprinkler escutcheons shall be metal and shall be listed for use with the sprinklers. Recessed sprinklers and escutcheons shall be UL listed and/or FM approved as an assembly and the sprinkler and escutcheon shall be of the same manufacturer.

2.07 IDENTIFICATION SIGNS

A. Contractor shall furnish and install hydraulic calculation signs for each new sprinkler zone. Hydraulic calculation signs shall be affixed to the corresponding system riser downstream of the system control valve and main drain at the riser. Contractor shall also provide identification signs for all valves installed under this Section.

B. Hydraulic calculation signs shall include all information indicated in NFPA 13 and its appendices. Valve identification signs shall identify the function of the valve and the area served.

C. Identification signs shall be rigid, metal plaques with embossed enamel background and lettering. Signs shall be secured by chain or durable wire to each sprinkler zone control valve, main and auxiliary drain and inspector's test valve. System hydraulic calculation placards affixed using adhesives and/or using permanent marker for information is NOT acceptable.

2.08 FIRE DEPARTMENT CONNECTION AND HOSE EQUIPMENT

A. Fire Department Connections: Fire Department Connection (FDC) shall be located in accordance with code and jurisdiction requirements. If not shown on the civil documents, the Fire Department Connection shall serve the system riser as required by the CFC and NFPA 13, and shall be in close proximity to the riser served. The number of 2-1/2 inch inlets shall be as required by NFPA and Contractor shall match threads to the requirements of the local fire department the FDC shall have a brass cast body. The FDC shall be a yard-mounted style and shall be brass, polished chrome or safety yellow painted finish and shall be complete with matching trim ring of the same finish. The trim ring will be clearly marked for the
service - Automatic Sprinklers. Outlets will be equipped with threaded caps of matching finish and such caps will be attached to the FDC with chains of the appropriate finish. The FDC and appurtenances will be of a single manufacturer and the unit will be UL listed and California State Fire Marshal approved for its intended service and acceptable to Architect/Owner and AHJ.

2.09 SUPERVISORY AND ALARM EQUIPMENT

A. All water flow and valve supervisory switches shall be furnished, installed and properly adjusted by the sprinkler contractor. Alarm monitoring of these devices will be by others.

B. Contacts: All water flow and valve supervisory switches shall be provided with two “Form C” (D.P.D.T.) contacts for monitoring. Specific contact rating shall be coordinated with the fire alarm contractor.

C. Water flow Switches: Vane-type and/or pressure-type water flow indicators shall be provided to indicate water flow in each sprinkler system zone and shall be UL listed and/or FM approved. All water flow switches shall be equipped with an adjustable retard setting that can be varied from 0 to 60 (minimum) seconds.

D. Supervisory Switches: Valve supervisory (tamper) switches shall be provided for all valves controlling the water supply to the sprinkler systems. Valve supervisory switches for OS&Y type valves shall be the yoke mounted or integral type. Supervisory switches for butterfly style valves shall be factory installed and integral to the valve assembly.

2.10 INSPECTOR’S TEST AND DRAIN ASSEMBLY

A. The inspector’s test and drain assembly shall be installed downstream of the water flow alarm device as permitted by NFPA 13. The discharge of the inspector’s test valve and drain shall be at a location approved by the Architect/Owner.

B. The inspector’s test and drain assemblies shall comply with the requirements of NFPA 13. All components of test and drain assemblies shall be UL listed and/or FM approved.

2.11 MISCELLANEOUS PRODUCTS

A. Pressure Gauges: Pressure gauges shall be UL listed 3-1/2 inch minimum diameter, dial type gauges with a maximum limit of not less than twice the normal working pressure at the point installed. All gauges shall be provided with 1/4 inch, 3-way shut-off valve (gauge-cock).
6.01 WORKING CONDITIONS

A. Contractor shall visit the site and become familiar with the conditions under which the work will be performed.

B. Contractor’s installation shall be performed from Monday through Friday between the hours of 6:30 a.m. and 5:30 p.m., unless otherwise specified by the School District. Contractor will have site access during working hours.

C. Weekend and after-hours work are to be approved by the School District in writing.

3.02 PREPARATION FOR WORK

A. Cooperation with other trades: Contractor shall coordinate with the work of the other trades towards the general purpose of having the construction progress as rapidly and as smoothly as possible with a minimum of interference between trades.

B. Before the start of Structural Work, Contractor shall submit to Architect/Owner locations, sizes, and instructions for openings and penetrations required for his work. Submittal and proposed penetrations shall be subject to Architect/Owner. In general, penetrations of primary structural members are not permitted.

C. Approval prior to installation: No work shall commence prior to approval of shop drawings by the approving authorities, including Architect/Owner. Any change in work that has been installed prior to approval of the shop drawings shall be made without additional compensation to Contractor.

3.03 GENERAL INSTALLATION

A. Aesthetics shall be a primary consideration when installing sprinklers and sprinkler piping in all areas. Any facet of sprinkler installation that deviates from the approved shop drawings and does not meet with Architect/Owner’s approval shall be revised by Contractor to Architect/Owner’s satisfaction at no additional cost.

B. All holes made by Contractor in any wall, ceiling, or floor shall be patched by Contractor, restoring the wall, ceiling, floor or member to its intended condition, fire resistance, and integrity.

C. Location of all equipment, controls, piping, valves and drains shall be subject to Architect/Owner’s approval.

D. All sprinklers and equipment shall be installed in accordance with manufacturers’ instructions. All special tools including sprinkler wrenches, recommended by the manufacturer shall be used.
E. Sprinklers shall be installed with the deflector to ceiling distances in accordance with their UL listings and/or FM approval and the requirements of NFPA 13.

3.04 PIPING

A. All sprinkler piping installed in public areas or non-public areas with suspended ceilings shall be concealed in the walls, ceilings or soffits. Pipe in unfinished areas may be exposed.

B. All piping exposed within the building public areas shall be painted with one coat by Contractor. Architect/Owner is to select the colors. All exterior piping shall be primed with zinc chromate and painted by Contractor.

C. Escutcheon Plates: All exposed pipe which passes through a wall, ceiling, or floor shall be provided with metal escutcheon plates.

D. Minimum Height: All exposed piping and devices shall be installed as high as possible, but no less than seven (7) feet clear above the finished floor in traffic or working areas, so as not to obstruct any portion of a window, doorway, stairway or passageway. Pipe and fittings shall not interfere with the operation or accessibility of any mechanical, plumbing or electrical equipment.

E. Operating Chains: Valves controlling water supply to the sprinkler systems shall be less than seven (7) feet above the finished floor. When specifically approved by Architect/Owner, they may be higher and must be provided with operating chains.

F. Protection: Contractor shall provide Architect/Owner approved, adequate permanent protection for any installed piping, valves, devices or accessories which in Architect/Owner’s opinion, are subject to physical damage or may be hazards.

G. Firestopping: Pipe that passes through fire-rated resistive barriers (including shaft walls) shall be sleeved and grouted or sealed with a UL listed through-penetration fire stop system to maintain the integrity and rating of the fire resistive barrier.

H. Testing: All piping is to be flushed and hydraulically tested prior to acceptance by Architect/Owner. Flushing and testing must be performed in accordance with NFPA standards.

I. Contractor shall provide all equipment necessary for testing and flushing and any special equipment required for the installation of any portion of sprinkler system. Contractor shall remove all such equipment at the end of the job.

J. All above ground piping 2-1/2” and larger shall be provided with labels at 20-foot intervals indicating sprinkler system piping.
3.05 SYSTEM TEST AND DRAIN CONNECTIONS

A. Contractor shall provide all test valves and drain connections as required by NFPA 13.

B. All test connections and drain riser connections shall be hard piped to discharge waste water to the exterior of the building or as required by the AHJ. When acceptable to Architect/Owner, drain piping may terminate at an interior drain of sufficient size and capacity to accommodate the anticipated maximum flow. The sprinkler contractor shall coordinate routing of the drain pipe and points of discharge.

3.06 RISERS

A. Contractor shall locate the main risers for the sprinkler system to minimize obstruction or traffic or building operations.

B. Zoning: The fire sprinkler system shall be zoned on a per floor basis and divided into zones as noted herein (and/or on the riser diagram shown on the contract drawings). Sprinkler zones shall not exceed the maximums specified in NFPA 13. Sprinkler zoning (and alarms) will also conform to alarm and detection and/or smoke control system zoning.

C. Supervisory Switches: Valve supervisory switches shall be provided on all valves controlling water supply to the fire sprinkler system, including valves located at backflow preventers.

3.07 FLUSHING AND SANITATION

A. All equipment and materials prior to installation shall be clean inside and outside. All waste material such as chips, filings, welding stubs, dirt, rags, debris, and any other foreign material shall be removed from the components before assembly.

B. All steel pipe coupons or punched holes for welded or mechanical outlets shall be attached to the pipe near the pipe hole. Protective plastic caps shall be located over openings and pipe ends during installation to prevent foreign material from entering the pipe at any time.

3.08 SEISMIC CONSIDERATIONS

A. Sprinkler piping on any floor level may cross building structural separations such as expansion and seismic joints, provided that the piping is specifically designed with flexible connections at each crossing and able to accommodate the calculated differential motions during an earthquake, but not less than a minimum of 24 inches. All required structural, differential movement and drift calculations shall be prepared by a licensed structural engineer possessing current California registration. The seismic separation assembly shall be Metraflex Fire loop, as indicated on the design drawings. Contractor shall verify locations of seismic joints.
3.09 SWAY BRACING, FLEXIBLE COUPLINGS, HANGERS

A. All flexible couplings, hangers and sway bracing shall be designed and installed as required by NFPA 13 (including all appendices) and in accordance with their listings and/or approvals. Flexibility, internal pressure and differential movement between the piping and building, earth, or other supporting structure shall be allowed for, so that no allowable stress is exceeded in any member.

3.10 TRAINING

A. Contractor shall conduct two (2) training sessions of four (4) hours each at the project site to familiarize the building personnel with the features, operation and maintenance of the sprinklers. Training sessions shall be scheduled by Architect/Owner at a time mutually agreeable to Contractor and Architect/Owner.

B. Agenda: Contractor shall submit a proposed training agenda for Architect/Owner’s review and approval within 60 days of receipt of authorization to proceed. The proposed training agenda shall include, but not be limited to the following:
   1. Overview of system operation
   2. Overview of system equipment and device locations
   3. Detailed operation guidelines
   4. Detailed maintenance procedures
   5. Periodic testing procedures

C. Final Agenda: Contractor shall submit the final approved training agenda 14 days prior to the first training session.

3.11 FINAL INSPECTION AND TEST

A. Contractor shall make arrangements with Architect/Owner for Architect/Owner’s final inspection and witnessing of the final acceptance tests. This test shall be separate from testing by the local authorities.

B. All tests and inspections required by the referenced Codes and Standards, AHJ, and Architect/Owner shall be conducted by Contractor under this scope of work.
   1. When AHJ are required to witness tests, Contractor shall be responsible for making all necessary arrangements with the code authorities and coordinating the testing with Architect/Owner.
   2. Contractor shall be responsible for completing all test documents with necessary approval stamps and signatures of the AHJ. Contractor shall submit one copy of each of these documents to Architect/Owner for their records.

C. Acceptance Testing: Upon completion of each system, perform and document on an NFPA or approved format, system tests as described herein. All acceptance tests shall be performed in the presence of Architect/Owner.
   1. Hydrostatic tests.
2. Flushing of piping
3. Test of sprinkler supervisory system - The Alarm and Detection Contractor should be present at the time of testing of all sprinkler alarm and supervisory devices. This Contractor shall coordinate the final testing of all such devices with the Alarm and Detection Contractor.

D. Contractor shall provide at least a five (5) working day notice for all tests to all involved.

3.12 FINAL APPROVAL

A. Final approval and acceptance of the work will be given by Architect/Owner when:
1. The completed sprinkler system has been inspected, tested and approved by Architect/Owner and AHJ.
2. Required submittals, system operation and maintenance manuals, record drawings, spare parts, special tools and training have been provided to be reviewed and accepted by Architect/Owner.
3. Written certification is submitted that states all equipment has been inspected and tested by a manufacturer’s certified representative.
4. Written certification is submitted that states all equipment has been inspected and tested by a manufacturer’s certified representative.

B. Architect/Owner’s Representative may visit the jobsite to observe the work and witness the final acceptance tests when advised by Contractor that the work is complete and ready for testing. If the work has not been completed or the test is unsatisfactory, Contractor shall be responsible for Architect/Owner’s added expenses for re-inspection and witnessing the retesting of the work. Such extra fees shall be deducted from payments by Architect/Owner to Contractor.

C. Additional Tests: Any additional tests required by the referenced codes, standards, or criteria, or by Architect/Owner shall be performed. This documentation shall include:
1. The date and time of each test
2. A reference set of contractor record drawings, numerically identifying the individual components and circuits tested and test locations.
3. A description of each test performed
4. A checklist of each device tested indicating the results of each test
5. The names and signatures of the individuals conducting and witnessing each test.
3.13 FIELD QUALITY CONTROL

A. Scheduling of Work:
   1. Coordinate the installation schedule for this portion of the work with the overall construction schedule for the project to ensure orderly progress of the work without delay.
   2. Coordinate the interface of the automatic sprinkler system with the work of all other trades as well as new construction to ensure proper and adequate provision for the installation and connection of this system.

3.14 HOUSEKEEPING

A. Upon completion of the work the Contractor will completely remove all debris and excess materials from the jobsite.

3.15 GUARANTEE PERIOD

A. Except as otherwise expressly provided in the Contract Documents and excepting only items of routine maintenance, ordinary wear and tear or unusual abuse or neglect, Contractor guarantees all work executed by Contractor and all supplies, materials, and devices of whatsoever nature incorporated in, or attached with the work, or otherwise delivered to the Architect/Owner as part of the work pursuant to the contract to be absolutely free of all defects of workmanship and materials for a period of one year after final acceptance of the work by Architect/Owner’s representative.

B. Include service directory with telephone numbers for 24-hour emergency service.

END OF SECTION
SECTION 22 05 16

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Flexible pipe connectors.
   B. Expansion joints and compensators.
   C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS
   A. Section 22 10 05 - Plumbing Piping.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data:
      1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

1.05 REGULATORY REQUIREMENTS
   A. Conform to UL (DIR) requirements.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING
   A. Manufacturers:
   B. Joint: Flanged.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING
   A. Manufacturers:
   B. Pressure Rating: 125 psi and 450 degrees F (862 kPa and 232 degrees C).
   C. Joint: Flanged.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION 22 05 16
HEAT TRACING FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Self-regulating parallel resistance electric heating cable.
B. Cable outer jacket markings.
C. Connection kits.
D. Accessories.
E. Controls.

1.02 RELATED REQUIREMENTS
A. Section 22 05 53 - Identification for Plumbing Piping and Equipment
B. Section 22 10 05 - Plumbing Piping.
C. Section 22 10 06 - Plumbing Piping Specialties.
D. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
E. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
F. Section 26 05 34 - Conduit.

1.03 REFERENCE STANDARDS
B. ITS (DIR) - Directory of Listed Products; current edition.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.
C. Coordinate the work with other trades to provide ground fault protection for electric heat tracing circuits as required by NFPA 70.
D. Coordinate the work with other trades to provide circuit breaker ratings suitable for installed circuit lengths.
1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
   B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
   C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide two year manufacturer warranty for cables, connection kits, accessories, and controls.

PART 2 PRODUCTS

2.01 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE
   A. Manufacturers:
   B. Provide products listed, classified, and labeled by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction (AHJ).
   D. Heating Element:
      1. Provide pair of parallel No.16 tinned or nickel coated stranded copper bus wires embedded in cross linked conductive polymer core with varying heat output in response to temperature along its length.
      2. Terminations: Waterproof, factory assembled, non-heating leads with connector at one end and water-tight seal at opposite end.
      3. Capable of crossing over itself without overheating.
   E. Insulated Jacket: Flame retardant polyolefin.
   F. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.
   G. Maximum Power-On Operating Temperature: 150 degrees F (65 degrees C).
   H. Maximum Power-Off Exposure Temperature: 185 degrees F (85 degrees C).
   I. Electrical Characteristics:

2.02 CABLE OUTER JACKET MARKINGS
   A. Name of manufacturer, trademark, or other recognized symbol of identification.
   B. Catalog number, reference number, or model.
C. Month and year of manufacture, date coding, applicable serial number, or equivalent.

D. Agency listing or approval.

2.03 CONNECTION KITS

A. Provide power connection, splice/tee, and end seal kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.

B. Provide with NEMA 4X rating for prevention of corrosion and water ingress.

2.04 ACCESSORIES

A. Provide Accessories As Indicated or As Required for Complete Installation, including but not limited to:
   1. High temperature, glass filament tape for attachment of heating cable to metal piping.
   2. Aluminum self-adhesive tape for attachment of heating cable to plastic piping.
   3. Heat-conductive putty.
   4. Cable ties.
   5. Silicone end seals and splice kits.
   6. Installation clips.
   7. Warning labels for attachment to exterior of piping insulation. Refer to Section 22 05 53.

2.05 CONTROLS

A. Pipe Mounted Thermostats:
   1. Remote bulb unit with adjustable temperature range from 30 to 50 degrees F (minus one to 10 degrees C).
   2. Snap-action, open-on-rise, single pole switch with minimum current rating adequate for the connected cable.
   3. Remote bulb on capillary, resistance temperature device (RTD) or thermistor for direct sensing of pipe wall temperature.

B. Provide minimum 30 ampere contactor to indicate operational status and on/off control.

C. Line sensing high-limit temperature control and high-limit alarm.

D. Programmable Controller:
   2. Capable of four separate schedules.
   3. On/Off/Auto switch.
   4. 365 day calendar with 20 programmable holidays.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping and equipment are ready to receive work.

B. Verify field measurements are as shown on shop drawings.

C. Verify required power is available, in proper location, and ready for use.

3.02 PREPARATION

A. Clean exposed surfaces prior to installation.
B. Prepare surfaces using approved methods as recommended by manufacturer.

3.03 INSTALLATION

A. Install in accordance with manufacturer’s written installation instructions.
B. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.
C. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.
D. Comply with applicable local building codes and requirements of authorities having jurisdiction.
E. Identification:
   1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft (6 m) including cladding over each valve or other equipment that may require maintenance.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Perform start-up by factory technician or factory representative as per Owner’s requirements.
C. Field Testing and Inspections:
   1. Commission system in accordance with installation and operation manual.
   2. Inspect for sources of water entry and proper sealing.
   3. Inspect weather barrier to confirm that no sharp edges are contacting the trace heating.
   4. Insulation Resistance: Greater than 20 megohms at a test voltage of 2500 VDC for polymer insulated trace heaters.
   5. Test heating cable integrity with megohmmeter at the following intervals:
   6. Measure voltage and current at each unit.
   7. Controls:

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals.
B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

3.06 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 22 05 33
SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Equipment support bases.
B. Vibration isolators.
C. Seismic restraints for suspended components and equipment.

1.02 REFERENCE STANDARDS

B. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association; 2008.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data:
   1. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS.
   2. Include seismic rating documentation for each isolator and restraint component accounting for horizontal, vertical, and combined loads.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General:
   1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.

2.02 EQUIPMENT SUPPORT BASES

2.03 VIBRATION ISOLATORS

2.04 SEISMIC RESTRAINTS FOR SUSPENDED COMPONENTS AND EQUIPMENT

A. Comply with:
   1. SMACNA (SRM).
B. Cable Restraints:
   1. Wire Rope: Steel wire strand cables sized to resist seismic loads in all lateral directions.
   3. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
   4. Connections:
a. Use overlapping wire rope U clips, cable clamping bolts, swaged sleeves or seismically rated tool-less wedge insert lock connectors.
b. Internally brace clevis hanger bracket cross bolt to prevent deformation.

5. Vertical Suspension Rods: Attach required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

C. Rigid Restraints:
1. Structural Element: Sized to resist seismic loads in all lateral directions and carry both compressive and tensile loading.
2. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
3. Connections: Internally brace clevis hanger bracket cross bolt to prevent deformation.
4. Static Support System: Anchorage capable of carrying additional tension loads generated by the vertical component of the rigid brace compression which is additive to any static load requirements on the system.
5. Vertical Suspension Rods: Attached required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL
A. Install in accordance with manufacturer’s instructions.

3.02 INSTALLATION - SEISMIC
A. Piping:
1. Provide seismic bracing in accordance ASCE 7.
2. Provide supports, braces, and anchors to resist gravity and seismic design forces.
3. Provide flexible connections between floor mounted equipment and suspended piping; between unbraced piping and restrained suspended items; as required for thermal movement; at building separations and seismic joints; and wherever relative differential movements could damage pipe in an earthquake.
4. Brace resiliently supported pipe with cable bracing or alternate means designed to prevent transmission of vibrations and noise to the structure.
5. Brace every run 5.0 feet (1.5 m) or more in length with two transverse and one longitudinal bracing locations.
6. Pipes and Connections Constructed of Ductile Materials (copper, ductile iron, steel or aluminum and brazed, welded or screwed connections):
   a. Provide transverse bracing at spacing not more than 40.0 feet (12.2 m) on center.
   b. Provide longitudinal bracing at spacing not more than 80.0 feet (24.4 m) on center.
7. Pipes and Connections Constructed of Non Ductile Materials (cast iron, no-hub, plastic or non-UL listed grooved coupling pipe):
   a. Provide transverse bracing at spacing not more than 20.0 feet (6.1 m) on center.
   b. Provide longitudinal bracing at spacing not more than 40.0 feet (12.2 m) on center.
8. Provide lateral restraint for risers at not more than 30 feet (9.1 m) on center or as required for horizontal runs, whichever is less.

9. Piping Explicitly Exempt from Seismic Bracing Requirements:
   a. Provide flexible connections between piping and connected equipment, including in-line devices such as VAV boxes and reheat coils.
   b. Install piping consistent with ASCE 7, such that swinging of the pipes will not cause damaging impact with adjacent components, finishes, or structural framing while maintaining clear horizontal distance of 67 percent of the hanger length between subject components.
   c. Provide swing restraints as required to control potential impact due to limited space between subject components.

10. Use of proprietary restraint systems with a certificate of compliance, verified and listed by an accredited inspection body is acceptable (pending shop drawing approval), as an alternative to project specific seismic bracing design.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Inspect isolated equipment after installation and submit report. Include static deflections.

3.04 SCHEDULES
   A. Pipe Isolation Schedule.
      1. 1 Inch (25 mm) Pipe Size: Isolate 120 diameters from equipment.
      2. 2 Inch (50 mm) Pipe Size: Isolate 90 diameters from equipment.
      3. 3 Inch (80 mm) Pipe Size: Isolate 80 diameters from equipment.
      4. 4 Inch (100 mm) Pipe Size: Isolate 75 diameters from equipment.
      5. 6 Inch (150 mm) Pipe Size: Isolate 60 diameters from equipment.
      6. 8 Inch (200 mm) Pipe Size: Isolate 60 diameters from equipment.
      7. 10 Inch (250 mm) Pipe Size: Isolate 54 diameters from equipment.

END OF SECTION 22 05 48
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Stencils.
D. Pipe markers.
E. Ceiling tacks.

1.02  RELATED REQUIREMENTS
A. Section 09 91 23 - Interior Painting: Identification painting.

1.03  REFERENCE STANDARDS

1.04  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturers catalog literature for each product required.

PART 2  PRODUCTS

2.01  IDENTIFICATION APPLICATIONS
A. Piping: Tags.
B. Pumps: Nameplates.
C. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02  NAMEPLATES
A. Description: Laminated three-layer plastic with engraved letters.

2.03  TAGS
A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.
B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

2.04  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.  

B. Stencil Paint: As specified in Section 09 91 23, semi-gloss enamel, colors  
   conforming to ASME A13.1.  

2.05 PIPE MARKERS  
A. 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. Underground Plastic Pipe Markers: Bright colored continuously printed  
   plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm)  
   thick, manufactured for direct burial service.  
E. Color code as follows:  
   1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.  
   2. Fire Quenching Fluids: Red with white letters.  
   3. Toxic and Corrosive Fluids: Orange with black letters.  
   4. Flammable Fluids: Yellow with black letters.  

2.06 CEILING TACKS  
A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.  
B. Color code as follows:  
   1. Plumbing Valves: Green.  

PART 3 EXECUTION  

3.01 PREPARATION  
A. Degrease and clean surfaces to receive adhesive for identification materials.  

3.02 INSTALLATION  
A. Install plastic 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 underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

END OF SECTION 22 05 53
PART 1  GENERAL

1.01  SECTION INCLUDES
   A.  Piping insulation.
   B.  Jackets and accessories.

1.02  REFERENCE STANDARDS
   A.  ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

1.03  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.
   C.  Manufacturer's Instructions:  Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.04  DELIVERY, STORAGE, AND HANDLING
   A.  Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.05  FIELD CONDITIONS
   A.  Maintain ambient conditions required by manufacturers of each product.
   B.  Maintain temperature before, during, and after installation for minimum of 24 hours.
PART 2 PRODUCTS

2.01 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.

2.02 GLASS FIBER

A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. 'K' ('Ksi') Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
   3. Maximum Moisture Absorption: 0.2 percent by volume.

2.03 CELLULAR GLASS

A. Insulation: ASTM C552, Type II.
   1. Apparent Thermal Conductivity; 'K' ('Ksi') Value: Grade 6, 0.35 at 100 degrees F (0.050 at 38 degrees C).
   2. Service Temperature: Up to 800 degrees F (427 degrees C).
   3. Water Vapor Permeability: 0.005 perm inch (0.007 ng/Pa s m).
   4. Water Absorption: 0.5 percent by volume, maximum.

2.04 POLYETHYLENE

A. Manufacturers:
   1. Armacell LLC: www.armacell.us.

B. Insulation: Flexible closed-cell polyethylene tubing, slit lengthwise for installation, complying with applicable requirements of ASTM D1056.
   1. 'K' ('Ksi') Value: ASTM C177; 0.25 at 75 degrees F (0.036 at 24 degrees C).
   3. Density: 2 lb/cu ft (32 kg/cu m).
   4. Maximum Moisture Absorption: 1.0 percent by volume.
   5. Moisture Vapor Permeability: 0.05 perm inch (0.073 ng/Pa s m), when tested in accordance with ASTM E96/E96M.
   6. Connection: Contact adhesive.

2.05 JACKETS

A. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
   1. Thickness: 0.010 inch (0.25 mm).
   2. Finish: Smooth.
   3. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.
3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION 22 07 19
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
   1. Sanitary sewer.
   2. Chemical resistant sewer.
   3. Domestic water.
   4. Storm water.
   5. Gas.
   6. Flanges, unions, and couplings.
   7. Pipe hangers and supports.
   8. Valves.
   10. Check.
   12. Relief valves.
   13. Strainers.

1.02 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 08 31 00 - Access Doors and Panels.
C. Section 09 91 13 - Exterior Painting.
D. Section 09 91 23 - Interior Painting.
E. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.
F. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
G. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
H. Section 22 07 19 - Plumbing Piping Insulation.
I. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.
J. Section 31 23 16 - Excavation.
K. Section 31 23 16.13 - Trenching.
L. Section 31 23 23 - Fill.
M. Section 33 13 00 - Disinfecting of Water Utility Distribution.

1.03 REFERENCE STANDARDS

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
F. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; 2012.
H. ASME B31.9 - Building Services Piping; 2014.
K. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems; 2009.
R. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
S. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2013.
Y. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2010.
Z. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2013.
AA. AWWA C651 - Disinfecting Water Mains; 2005.
AF. MSS SP-67 - Butterfly Valves; 2011.
AG. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.

1.04 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. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

1.05 QUALITY ASSURANCE
A. Perform work in accordance with applicable codes.
B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
C. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
D. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 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.

1.07 FIELD CONDITIONS
A. Do not install underground piping when bedding is wet or frozen.
PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Cast Iron Pipe: CISPI 301, hubless.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

B. Copper Tube: ASTM B306, DWV.

2.03 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

B. Copper Tube: ASTM B306, DWV.

2.04 CHEMICAL RESISTANT SEWER PIPING

A. PP Pipe: Polypropylene, flame retardant.
   1. Fittings: Polypropylene.

2.05 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Copper Pipe: ASTM B42, hard drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

2.06 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

2.07 STORM WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

2.08 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74 extra heavy weight.
   1. Fittings: Cast iron.
   2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

2.09 NATURAL GAS PIPING, BURIED BEYOND 5 FEET (1500 MM) OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11.
1. Fittings: ASTM D2683 or ASTM D2513 socket type.

2.10 NATURAL GAS PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil (0.25 mm) polyethylene tape.

2.11 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
2. Joints: Threaded or welded to ASME B31.1.

2.12 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches (80 mm) and Under:
1. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.13 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.

B. Plumbing Piping - Drain, Waste, and Vent:
1. Hangers for Pipe Sizes 1/2 Inch (15 mm) to 1-1/2 Inches (40 mm): Malleable iron, adjustable swivel, split ring.
2. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
3. Wall Support for Pipe Sizes to 3 Inches (80 mm): Cast iron hook.
4. Wall Support for Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:
1. Hangers for Pipe Sizes 1/2 Inch (15 mm) to 1-1/2 Inches (40 mm): Malleable iron, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 Inches (50 mm) to 4 Inches (100 mm): Carbon steel, adjustable, clevis.
4. Wall Support for Pipe Sizes to 3 Inches (80 mm): Cast iron hook.
5. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Floor Support for Hot Pipe Sizes to 4 Inches (100 mm): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.

D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   2. Concrete Screw Type Anchors: Complying with ICC-ES AC193.

2.14 GATE VALVES
A. Manufacturers:
B. Up To and Including 3 Inches (80 mm):
   1. 1, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.

2.15 GLOBE VALVES
A. Manufacturers:
B. Up To and Including 3 Inches (80 mm):
   1. 1, Class 125, bronze body, bronze trim, handwheel, bronze disc, solder ends.

2.16 BALL VALVES
A. Manufacturers:

2.17 BUTTERFLY VALVES
A. Construction 1-1/2 Inches (40 mm) and Larger: MSS SP-67, 200 psi (1380 kPa) CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.
B. Provide gear operators for valves 8 inches (150 mm) and larger, and chain-wheel operators for valves mounted over 8 feet (2400 mm) above floor.

2.18 FLOW CONTROLS
A. Manufacturers:
B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
C. Calibration: Control flow within five percent of selected rating, over operating pressure range of ten times minimum pressure required for control, maximum minimum pressure 3.5 psi (24 kPa).

2.19 SWING CHECK VALVES
A. Manufacturers:

2.20 SPRING LOADED CHECK VALVES
A. Manufacturers:
B. Class 125, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

2.21 WATER PRESSURE REDUCING VALVES:
A. Manufacturers:
B. Up to 2 Inches (50 mm):
   1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
C. Over 2 Inches (50 mm):
   1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.22 RELIEF VALVES
A. Pressure Relief:
   1. 1 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.
B. Temperature and Pressure Relief:
   1. 2 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F (98.9 degrees C), capacity 1 certified and labelled.

2.23 STRAINERS
A. Manufacturers:
B. Size 2 inch (50 mm) and Under:
   1. Threaded brass body for 175 psi (1200 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
   2. Class 150, threaded bronze body 300 psi (2070 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 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.

3.03 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
   C. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
      1. Refer to Section 22 07 19.
   D. Provide access where valves and fittings are not exposed.
      1. Coordinate size and location of access doors with Section 08 31 00.
   E. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
   F. Provide support for utility meters in accordance with requirements of utility companies.
   G. 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.
   H. 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.

3.04 APPLICATION
   A. Install unions downstream of valves and at equipment or apparatus connections.
   B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

3.05 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.
   B. Water Piping: Slope at minimum of 1/32 inch per foot (1:400) and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
   A. Disinfect water distribution system in accordance with Section 33 13 00.
B. Prior to starting work, verify system is complete, flushed and clean.

C. 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).

D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

F. Maintain disinfectant in system for 24 hours.

G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

I. 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.

### 3.07 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.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
   2. Provide 18 gage, 0.0478 inch (1.21 mm) galvanized sheet metal sleeve around service main to 6 inch (150 mm) above floor and 6 feet (1800 mm) minimum below grade. Size for minimum of 2 inches (50 mm) of loose batt insulation stuffing.

C. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 7 inch wg (1.75 kPa). Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

### 3.08 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).
      d. Pipe Size: 4 inches (100 mm) to 6 inches (150 mm):
         1) Maximum Hanger Spacing: 10 ft (3 m).
         2) Hanger Rod Diameter: 5/8 inch (15 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 10 06

PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Drains.
B. Cleanouts.
C. Hose bibbs.
D. Hydrants.
E. Washing machine boxes and valves.
F. Refrigerator valve and recessed box.
G. Backflow preventers.
H. Double check valve assemblies.
I. Water hammer arrestors.
J. Sumps and interceptors.
K. Mixing valves.

1.02 RELATED REQUIREMENTS
A. Section 01 10 00 - Summary: Product requirements for Owner furnished kitchen equipment.
B. Section 01 60 00 - Product Requirements: Procedures for Owner-supplied products.
C. Section 22 10 05 - Plumbing Piping.
D. Section 22 30 00 - Plumbing Equipment.
E. Section 22 40 00 - Plumbing Fixtures.

1.03 REFERENCE STANDARDS
A. ASME A112.6.3 - Floor and Trench Drains; 2001 (R2007).
B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2003.
D. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers; 2011.
E. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011.
1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
C. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
D. Sustainable Design Documentation: Submit appropriate evidence that materials used in potable water systems comply with the specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS
2.01 GENERAL REQUIREMENTS
A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS
A. Manufacturers:
B. Roof Drains:
1. Assembly: ASME A112.6.4.
2. Body: Lacquered cast iron with sump.
3. Accessories: Coordinate with roofing type, refer to Section 075000
   a. Membrane flange and membrane clamp with integral gravel stop.
   b. Adjustable under deck clamp.
   c. Roof sump receiver.
   d. Waterproofing flange.
   e. Controlled flow weir.
   f. Leveling frame.
   g. Adjustable extension sleeve for roof insulation.
   h. Perforated or slotted ballast guard extension for inverted roof.
C. Roof Overflow Drains:
1. Lacquered cast iron body and clamp collar and bottom clamp ring; pipe extended to 2 inches (51 mm) above flood elevation.
D. Downspout Nozzles:
1. Bronze round with straight bottom section.
E. Area Drains:
1. Assembly: ASME A112.6.4.
2. Body: Lacquered cast iron with sump.
4. Accessories: Membrane flange and membrane clamp with integral gravel stop, with adjustable under deck clamp.
F. Floor Drain (FD-1):
1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

G. Floor Sink (FS-1):
1. Lacquered cast iron body with dome strainer and seepage flange.

2.03 CLEANOUTS

A. Manufacturers:

B. Cleanouts at Exterior Surfaced Areas (CO-1):
1. Round cast nickel bronze access frame and non-skid cover.

C. Cleanouts at Exterior Unsurfaced Areas (CO-2):
1. Line type with lacquered cast iron body and round epoxy coated gasketed cover.

D. Cleanouts at Interior Finished Wall Areas (CO-4):
1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

E. Cleanouts at Interior Unfinished Accessible Areas (CO-5): Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.04 HOSE BIBBS

A. Manufacturers:

B. Interior Hose Bibbs:
1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with handwheel, integral vacuum breaker in conformance with ASSE 1011.

2.05 HYDRANTS

A. Manufacturers:

B. Wall Hydrants:
1. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate hose thread spout, handwheel, and integral vacuum breaker.

2.06 WASHING MACHINE BOXES AND VALVES

A. Box Manufacturers:

B. Valve Manufacturers:

2.07 BACKFLOW PREVENTERS

A. Manufacturers:

B. Reduced Pressure Backflow Preventers:
   1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.08 DOUBLE CHECK VALVE ASSEMBLIES
   A. Manufacturers:

2.09 WATER HAMMER ARRESTORS
   A. Manufacturers:

2.10 SUMP AND INTERCEPTORS
   A. Manufacturers:
   B. Grease Interceptors:

2.11 MIXING VALVES
   A. Thermostatic Mixing Valves:
      1. Manufacturers:
         a. Apollo Valve Co.: www.apollovalves.com
         b. Leonard Valve Company: www.leonardvalve.com

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
   C. Encase exterior cleanouts in concrete flush with grade.
   D. Install floor cleanouts at elevation to accommodate finished floor.
   E. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
   F. Pipe relief from backflow preventer to nearest drain.
G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks or washing machine outlets.

END OF SECTION 22 10 06
SECTION 22 30 00

PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water Heaters:
   2. Commercial electric.

B. Packaged water heating systems.

C. Diaphragm-type compression tanks.

D. In-line circulator pumps.

E. Cooling condensate removal pumps.

F. Water heaters.

G. Compression tanks.

H. Pumps.
   1. Circulators.
   2. Cooling condensate removal pumps.

1.02 RELATED REQUIREMENTS

A. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

B. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.


1.04 REFERENCE STANDARDS

A. ANSI Z21.10.1 - Gas Water Heaters - Volume I - Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less; 2011.

B. ANSI Z21.10.3 - Gas-Fired Water Heaters - Volume III - Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous; 2014.

C. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.


1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 SUBMITTALS

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

B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
   4. Provide electrical characteristics and connection requirements.

C. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

D. Project Record Documents: Record actual locations of components.

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 Pump Seals: One of each type and size.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Identification: Provide pumps with manufacturer's name, model number, and rating/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, operate within 25 percent of midpoint of published maximum efficiency curve.

1.08 CERTIFICATIONS

A. Gas Water Heaters: Certified by CSA International to 1 or 2, as applicable, in addition to requirements specified elsewhere.

B. Electric Water Heaters: UL listed and labeled to UL 174 or UL 1453.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
1.09 DELIVERY, STORAGE, AND HANDLING
   A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.10 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 WATER HEATERS
   A. Manufacturers:
   B. Commercial Gas Fired:
      1. Type: Automatic, natural gas-fired, vertical storage.
      2. Performance:
      3. Tank: Glass lined welded steel ASME labeled; multiple flue passages, 4 inch (100 mm) diameter inspection port, thermally insulated with minimum 2 inches (50 mm) glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
      4. Accessories:
         b. Dip Tube: Brass.
         c. Drain valve.
         d. Anode: Magnesium.
      5. Certified For The Following Applications:
         a. Automatic storage water heater.
      6. Controls: Automatic water thermostat with temperature range adjustable from 120 to 180 degrees F (49 to 82 degrees C), automatic reset high temperature limiting thermostat factory set at 195 degrees F (90 degrees C), gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood.
   C. Commercial Electric:
      1. Type: Factory-assembled and wired, electric, vertical storage.
      2. Performance:
      3. Electrical Characteristics:
      4. Heating Elements: 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).

2.02 WATER HEATER MANUFACTURERS

2.03 COMMERCIAL GAS FIRED WATER HEATERS
   A. Type: Automatic, natural gas-fired, vertical storage.
   B. Performance:
   C. Tank: Glass lined welded steel ASME labeled; multiple flue passages, 4 inch (100 mm) diameter inspection port, thermally insulated with minimum
2 inches (50 mm) glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.

D. Accessories: Provide:
   2. Dip tube: Brass.
   3. Drain Valve.
   4. Anode: Magnesium.
   5. Temperature and Pressure Relief Valve: ASME labelled.

2.04 COMMERCIAL ELECTRIC WATER HEATERS
A. Type: Factory-assembled and wired, electric, vertical storage.
B. Performance:
C. Electrical Characteristics:
D. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 Watts per square inch.

2.05 DIAPHRAGM-TYPE COMPRESSION TANKS
A. 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 psig (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
B. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psig (80 kPa).

2.06 IN-LINE CIRCULATOR PUMPS
A. Casing: Bronze, rated for 125 psig (860 kPa) working pressure, with stainless steel rotor assembly.
B. Impeller: Bronze.
C. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
D. Seal: Carbon rotating against a stationary ceramic seat.
E. Drive: Flexible coupling.

2.07 COOLING CONDENSATE REMOVAL PUMPS
A. Construction: Commercial grade, nonferrous pump with stainless steel shaft, integral discharge check valve, integral float switch, safety switch, thermoplastic reservoir, motor assembly, and power cord with ground.
B. Safety: UL 778.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.
C. Domestic 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.

D. Pumps:
1. 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.

END OF SECTION 22 30 00
PART 1  GENERAL

1.01  SECTION INCLUDES

A.  Water closets.
B.  Urinals.
C.  Lavatories.
D.  Sinks.
E.  Service sinks.
F.  Electric water coolers.
G.  Drinking fountains.
H.  Showers.

1.02  RELATED REQUIREMENTS

A.  Section 01 10 00 - Summary: Owner-furnished fixtures.
B.  Section 06 41 00 - Architectural Wood Casework: Preparation of counters for sinks and lavatories.
C.  Section 07 92 00 - Joint Sealants: Sealing joints between fixtures and walls and floors.
D.  Section 11 40 00 - Foodservice Equipment: Food service sinks.
E.  Section 11 53 00 - Laboratory Equipment: Laboratory sinks.
F.  Section 22 10 05 - Plumbing Piping.
G.  Section 22 10 06 - Plumbing Piping Specialties.
H.  Section 22 30 00 - Plumbing Equipment.
I.  Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03  REFERENCE STANDARDS

B.  ASME A112.18.1 - Plumbing Supply Fittings; 2012.
C.  ASME A112.19.2 - Ceramic Plumbing Fixtures; 2013.
D.  ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use); 2008 (R2013).
E.  ASME A112.19.4M - Porcelain Enameded Formed Steel Plumbing Fixtures; 1994 (R2004).
1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
   C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 REGULATORY REQUIREMENTS
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Accept fixtures on site in factory packaging. Inspect for damage.
   B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS
2.01 GENERAL
   A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 FLUSH VALVE WATER CLOSETS
      1. Flush Valve: Exposed (top spud).
      3. Handle Height: 44 inches (1117 mm) or less.
   B. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
      1. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
   C. Seats:
      1. Manufacturers:
   D. Water Closet Carriers:
      1. Manufacturers:
2.03 WALL HUNG URINALS

A. Wall Hung Urinal Manufacturers:

   1. Flush Volume: 0.125 gallons (0.47 liters), maximum.
   2. Flush Valve: Exposed (top spud).
   4. Trap: Integral.

C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
   1. Sensor-Operated Type: Solenoid operator, low voltage hard-wired, infrared sensor and over-ride push button.
   2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.

D. Carriers:
   1. Manufacturers:

2.04 LAVATORIES

A. Lavatory Manufacturers:

B. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 34 max, with 4 inch (100 mm) high back, rectangular basin with splash lip, front overflow, and soap depression.
   1. Drilling Centers: 4 inch (100 mm).

2.05 SINKS

A. Sink Manufacturers:

B. Single Compartment Bowl: ASME A112.19.3; 19 by 21 by 5.5 inch (483 by 534 by 140 mm) outside dimensions 20 gage, 0.0359 inch (0.91 mm) thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

C. Double Compartment Bowl: ASME A112.19.3; 22 by 33 by 5.5 inch (559 by 838 by 140 mm) outside dimensions 20 gage, 0.0359 inch (0.91 mm) thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

2.06 SHOWERS

A. Cabinet: ASME A112.19.4M; porcelain enamelled steel, 32 by 32 by 75 inches (800 by 800 by 1900 mm) with stone texture receptor, soap dish, removable chrome plated strainer, tail piece, Chrome color.

B. Cabinet: ANSI Z124.1.2 reinforced glass fiber, 32 by 32 by 75 inches (800 by 800 by 1900 mm) with stone texture, integral receptor, soap dish, integral seat, removable chrome plated strainer, tail piece, Chrome color.
C. Trim: ASME A112.18.1; concealed shower supply with indexed handles, bent shower arm with adjustable spray ball joint showerhead with maximum 2.5 gallons per minute (9.5 liters per minute) flow, and escutcheon.

D. Trim: ASME A112.18.1; concealed shower supply with pressure balanced mixing valves, integral service stops, bent shower arm with adjustable spray ball joint shower head with maximum flow, and escutcheon.

E. Shower Head:
   1. ASME A112.18.1; chrome plated vandal-proof institutional head with integral wall bracket, built-in 2.5 gpm (0.16 L/s) flow control.

F. Low-Flow Shower Head:
   1. ASME A112.18.1; chrome plated vandal-proof institutional head with integral wall bracket, built-in 1.5 gpm (0.094 L/s) flow control.

G. Ultra-Low-Flow Shower Head:
   1. ASME A112.18.1; chrome plated vandal-proof institutional head with integral wall bracket, built-in 0.8 gpm (0.05 L/s) flow control.

2.07 DRINKING FOUNTAINS

A. Drinking Fountain Manufacturers:

2.08 ELECTRIC WATER COOLERS

A. Electric Water Cooler Manufacturers:
   3. Oasis, a Lynn Tilton Company:  www.oasiscoolers.com

B. Water Cooler: Electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.

2.09 SERVICE SINKS

A. Service Sink Manufacturers:
   2. Commercial Enameling Company:  www.cecosinks.com

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Install components level and plumb.
3.04 INTERFACE WITH WORK OF OTHER SECTIONS
   A. Review millwork shop drawings. Confirm location and size of fixtures and
      openings before rough-in and installation.

3.05 ADJUSTING

3.06 CLEANING
   A. Clean plumbing fixtures and equipment.
   B. See Section 01 74 19 - Construction Waste Management and Disposal, for
      additional requirements.

3.07 PROTECTION
   A. Protect installed products from damage due to subsequent construction
      operations.
   B. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 22 40 00
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1  GENERAL

1.01  SECTION INCLUDES

A. General construction and requirements.
B. Single phase electric motors.
C. Three phase electric motors.

1.02  REFERENCE STANDARDS

A. NEMA MG 1 - Motors and Generators; 2014.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03  QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for Commercial use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
B. Conform to NFPA 70.
C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.04  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.

1.05  WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2  PRODUCTS

2.01  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 1 limits for insulation class, service factor, and motor enclosure type.

   B. Construction:
      1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 40 degrees C environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. 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.

D. 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.

PART 3 EXECUTION

3.01 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.
SECTION 23 05 16

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Flexible pipe connectors.
B. Expansion joints and compensators.
C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS
A. Section 23 21 13 - Hydronic Piping.
B. Section 23 23 00 - Refrigerant Piping.

1.03 REFERENCE STANDARDS
B. EJMA (STDS) - EJMA Standards; Tenth Edition.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
C. Design Data: Indicate selection calculations.
D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
E. Maintenance Data: Include adjustment instructions.
F. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING
A. Inner Hose: Carbon Steel.
C. Pressure Rating: 125 psi and 450 degrees F (862 kPa and 232 degrees C).
D. Joint: Flanged.
E. Size: Use pipe sized units.
F. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING
A. Inner Hose: Bronze.
B. Exterior Sleeve: Braided bronze.
C. Pressure Rating: 125 psi and 450 degrees F (862 kPa and 232 degrees C).
D. Joint: Flanged.
E. Size: Use pipe sized units.
F. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.
G. Application: Copper piping.

2.03 EXPANSION JOINTS - SINGLE SPHERE, ELBOW COMPENSATOR
A. Body: Teflon.
B. Pressure Rating, Sizes 3/4 Inch to 2 Inch (20 mm to 50 mm): 150 psi and 210 degrees F (1040 kPa and 99 degrees C).
C. Pressure Rating, Sizes 1-1/2 Inch to 12 Inch (32 mm to 300 mm): 150 psi and 250 degrees F (1040 kPa and 121 degrees C).
D. Pressure Rating, Sizes 14 Inch to 24 Inch (350 mm to 600 mm): 105 psi and 250 degrees F (725 kPa and 121 degrees C).
E. Maximum Compression: 1/2 inch (13 mm).
F. Maximum Elongation: 3/8 inch (10 mm).
G. Maximum Offset: 3/8 inch (10 mm).
H. Maximum Angular Movement: 15 degrees.
I. Joint: Tapped steel flanges.
J. Size: Use pipe sized units.
K. Accessories: Control rods.
L. Application: Steel piping 2 inches (50 mm) and over.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION 23 05 16
SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Positive displacement meters.
   B. Pressure gages and pressure gage taps.
   C. Thermometers and thermometer wells.
   D. Static pressure gages.
   E. Filter gages.

1.02 RELATED REQUIREMENTS
   A. Section 23 21 13 - Hydronic Piping.

1.03 REFERENCE STANDARDS
   A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
   E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2015.
   G. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
   C. Project Record Documents: Record actual locations of components and instrumentation.

PART 2 PRODUCTS

2.01 POSITIVE DISPLACEMENT METERS (LIQUID)
   A. AWWA C700, positive displacement disc type suitable for fluid with metal alloy main case and cast iron frost-proof, breakaway bottom cap, hermetically sealed register, remote reading.
   B. Meter: Brass body turbine meter with magnetic drive register.
1. Service: Hot water, 200 degrees F (93 degrees C).
2. Accuracy: 1-1/2 percent.

### 2.02 PRESSURE GAGES

A. Pressure Gages: 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.

### 2.03 PRESSURE GAGE TAPPINGS

A. Gage 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.
D. Syphon: Steel, Schedule 40, 1/4 inch (6 mm) angle or straight pattern.

### 2.04 STEM TYPE THERMOMETERS

A. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
   1. Size: 9 inch (225 mm) scale.
   2. Window: Clear Lexan.
   3. Accuracy: 2 percent, per ASTM E77.
   4. Calibration: Degrees F.
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.

### 2.05 DIAL THERMOMETERS

A. 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.

### 2.06 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
B. Flange: 3 inch (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.
2.07 TEST PLUGS

A. Test Plug: 1/4 inch (6 mm) or 1/2 inch (13 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F (93 degrees C).

B. Test Plug: 1/4 inch (6 mm) or 1/2 inch (13 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with Nerdle core for temperatures up to 350 degrees F (176 degrees C).

C. Test Plug: 1/4 inch (6 mm) or 1/2 inch (13 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with Viton core for temperatures up to 400 degrees F (204 degrees C).

D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch (60 mm) diameter pressure gages, one gage adapters with 1/8 inch (3 mm) probes, two 1 inch (25 mm) dial thermometers.

2.08 STATIC PRESSURE GAGES

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.

C. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.

D. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gauge. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.

E. 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.

F. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

G. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION 23 05 19
SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Equipment support bases.
B. Vibration isolators.
C. Seismic restraints for suspended components and equipment.
D. Roof curbs.

1.02  REFERENCE STANDARDS

B. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel; International Accreditation Service, Inc; 2011.
C. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association; 2008.

1.03  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data:
   1. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS.
   2. Include seismic rating documentation for each isolator and restraint component accounting for horizontal, vertical, and combined loads.
C. Shop Drawings:
   1. Provide schedule of vibration isolator type with location and load on each.
   2. Fully dimensioned fabrication drawings and installation details for vibration isolation bases, member sizes, attachments to isolators, and supported equipment.
   3. Include auxiliary motor slide bases and rails, base weights, inertia bases, concrete weights, equipment static loads, support points, vibration isolators, and detailed layout of isolator location and orientation with static and dynamic load on each isolator.
   4. Include selections from prescriptive design tables that indicate compliance with the applicable building code and the vibration isolator manufacturer's requirements.
   5. Clearly indicate the load and capacity assumptions selected. Include copies of any calculations.
   6. Include the calculations that indicate compliance with the applicable building code for seismic controls and the vibration isolator manufacturer's requirements.
7. Include the seal of the Professional Structural Engineer registered in the State of California in which the Project is located, on the drawings and calculations which at a minimum include the following:
   a. Seismic Restraint Details: Detailed drawings of seismic restraints and snubbers including anchorage details that indicate quantity, diameter, and depth of penetration, edge distance, and spacing of anchors.
   b. Dimensioned outline drawings of equipment identifying center of gravity, locations, and provisions for mounting and anchorage.
   c. Detailed description of the equipment anchorage devices on which the certifications are based.
   D. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.04 QUALITY ASSURANCE
   A. Perform design and installation in accordance with applicable codes.
   B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS
   A. General:
      1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
      2. Steel springs to function without undue stress or overloading.
      3. Steel springs to operate in the linear portion of the load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
      4. Lateral to vertical stiffness ratio to not exceed 0.08 with spring deflection at minimum 75 percent of specified deflection.
      5. All equipment mounted on vibration isolated bases to have minimum operating clearance of 2 inches (50 mm) between the base and floor or support beneath unless noted otherwise.

2.03 EQUIPMENT SUPPORT BASES
   A. Structural Bases:
      1. Construction: Engineered, structural steel frames with welded brackets for side mounting of the isolators.
      2. Frames: Square, rectangular or T-shaped.
      3. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.

2.04 VIBRATION ISOLATORS
   A. Seismic Type:
      1. Coil Springs Consisting of Single Elements:
2.05 SEISMIC RESTRAINTS FOR SUSPENDED COMPONENTS AND EQUIPMENT

A. Comply with:
   1. SMACNA (SRM).

B. Cable Restraints:
   1. Wire Rope: Steel wire strand cables sized to resist seismic loads in all lateral directions.
   3. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
   4. Connections:
      a. Use overlapping wire rope U clips, cable clamping bolts, swaged sleeves or seismically rated tool-less wedge insert lock connectors.
      b. Internally brace clevis hanger bracket cross bolt to prevent deformation.
   5. Vertical Suspension Rods: Attach required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

C. Rigid Restraints:
   1. Structural Element: Sized to resist seismic loads in all lateral directions and carry both compressive and tensile loading.
   2. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
   3. Connections: Internally brace clevis hanger bracket cross bolt to prevent deformation.
   4. Static Support System: Anchorage capable of carrying additional tension loads generated by the vertical component of the rigid brace
compression which is additive to any static load requirements on the system.
5. Vertical Suspension Rods: Attached required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

2.06 ROOF CURBS

A. Seismic Type:
1. Non-isolated Curb and Fabricated Equipment Piers:
   a. Location: Between structure and rooftop equipment.
   b. Construction: Steel.
   c. Weather exposed components consist of corrosion resistant materials.
2. Vibration Isolation Curb:
   a. Location: Between structure and rooftop equipment.
   b. Construction: Steel.
   c. Integral vibration isolation to conform to requirements of this section.
   d. Snubbers consist of minimum 0.25 inch (6 mm) thick resilient pads to avoid metal-to-metal contact without compromising vibration isolating capabilities.
   e. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install in accordance with manufacturer’s instructions.
B. Bases:
   1. Set steel bases for one inch (25 mm) clearance between housekeeping pad and base.
   2. Set concrete inertia bases for 2 inches (50 mm) clearance between housekeeping pad and base.
   3. Adjust equipment level.
C. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
E. Provide pairs of horizontal limit springs on fans with more than 6.0 inches WC (1.5 kPa) static pressure, and on hanger supported, horizontally mounted axial fans.
F. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for scheduled distance.
   1. Up to 4 Inches (100 mm) Pipe Size: First three points of support.
   2. 5 to 8 Inches (125 to 200 mm) Pipe Size: First four points of support.
   3. 10 inches (250 mm) Pipe Size and Over: First six points of support.
   4. Select three hangers closest to vibration source for minimum 1.0 inch (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch (25 mm) static deflection or 1/2 static deflection of isolated equipment.
3.02 INSTALLATION - SEISMIC

A. Comply with:
   1. SMACNA (SRM).

B. Floor and Base-Mounted Equipment, Vibration Isolated Equipment and associated Vibration and Seismic Controls for Connections:
   1. Install equipment anchorage items designed to resist seismic design force in any direction.
   2. Install vibration and seismic controls designed to include base and isolator requirements.
   3. Provide flexible connections between equipment and interconnected piping.
   4. Provide isolators and restraints designed for amplified code forces per ASCE 7 and with demonstrated ability to resist required forces including gravity, operational and seismic forces.
   5. Where equipment is not designed to be point loaded, provide base capable of transferring gravity and seismic demands from equipment to isolator base plate anchorage.
   6. Where concrete floor thickness is less than required for expansion anchor installation, install through bolt in lieu of expansion anchor.
   7. Where timber/wood floor or other substrate is inadequate for installation of lag bolts, screws or other mechanical fasteners, install supplemental framing or blocking to transfer loads to structural elements.

C. Suspended Mechanical Equipment:
   1. Provide supports and bracing to resist seismic design force in any direction.
   2. Provide flexible connections between equipment and interconnected piping.
   3. Brace equipment hung from spring mounts using cable or other bracing that will not transmit vibration to the structure.
   4. Use of proprietary restraint systems with a certificate of compliance, verified and listed by an accredited inspection body is acceptable (pending shop drawing approval), as an alternative to project specific seismic bracing design.

D. Wall mounted Mechanical Equipment:
   1. Provide support and bracing to resist seismic design force in any direction.
   2. Install backing plates or blocking as required to deliver load to primary wall framing members.
   3. Anchoring to gypsum wallboard, plaster or other wall finish that has not been engineered to resist imposed loads is not permitted.

E. Piping:
   1. Provide seismic bracing in accordance ASCE 7.
   2. Provide supports, braces, and anchors to resist gravity and seismic design forces.
   3. Provide flexible connections between floor mounted equipment and suspended piping; between unbraced piping and restrained suspended items; as required for thermal movement; at building separations and seismic joints; and wherever relative differential movements could damage pipe in an earthquake.
4. Brace resiliently supported pipe with cable bracing or alternate means designed to prevent transmission of vibrations and noise to the structure.
5. Brace every run 5.0 feet (1.5 m) or more in length with two transverse and one longitudinal bracing locations.
6. Pipes and Connections Constructed of Ductile Materials (copper, ductile iron, steel or aluminum and brazed, welded or screwed connections):
7. Pipes and Connections Constructed of Non Ductile Materials (cast iron, no-hub, plastic or non-UL listed grooved coupling pipe):
8. Provide lateral restraint for risers at not more than 30 feet (9.1 m) on center or as required for horizontal runs, whichever is less.
9. Piping Explicitly Exempt from Seismic Bracing Requirements:
   a. Provide flexible connections between piping and connected equipment, including in-line devices such as VAV boxes and reheat coils.
   b. Install piping consistent with ASCE 7, such that swinging of the pipes will not cause damaging impact with adjacent components, finishes, or structural framing while maintaining clear horizontal distance of 67 percent of the hanger length between subject components.
   c. Provide swing restraints as required to control potential impact due to limited space between subject components.
10. Use of proprietary restraint systems with a certificate of compliance, verified and listed by an accredited inspection body is acceptable (pending shop drawing approval), as an alternative to project specific seismic bracing design.
11. Re-use of Existing Hangers:
   a. Re-using existing hangers at locations of seismic bracing are to be judged on a case-by-case basis by the registered project design professional.
   b. Unless otherwise shown on the drawings, it is assumed all hangers supporting new piping, located at a seismic brace, will be new.

F. Ductwork:
1. Provide seismic bracing for ducts with cross sectional area greater than 6 sq ft (0.56 sq m) (independent of duct contents).
2. Provide seismic bracing for all ducts containing hazardous materials.
3. Provide supports, braces, and anchors to resist gravity and seismic design forces.
4. Independently support in-line devices weighing more than 20 pounds (9.07 kg).
5. Independently support and brace all in-line devices weighing more than 75 pounds (34 kg).
6. Provide unbraced piping attached to braced in-line equipment with adequate flexibility to accommodate differential displacements.
7. Positively attach dampers, louvers, diffusers and similar appurtenances to ductwork with mechanical fasteners.
9. Install duct supports designed to resist not less than 150 percent of the duct weight.
10. The use of power driven fasteners is prohibited in the hanging of ducts weighing over 10 pounds (4.54 kg) per lineal foot (m) for seismic design categories D, E, and F.
11. Use of proprietary restraint systems with a certificate of compliance, verified and listed by an IAS AC172 accredited inspection body or
otherwise accepted by Authority Having Jurisdiction is acceptable (pending shop drawing approval), as an alternative to project specific seismic bracing design.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION 23 05 48
SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1  GENERAL

1.01 SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Pipe markers.
   D. Duct Labels.

1.02 REFERENCE STANDARDS

1.03 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.
   E. Project Record Documents: Record actual locations of tagged valves.

PART 2  PRODUCTS

2.01 IDENTIFICATION APPLICATIONS
   A. Air Handling Units: Nameplates.
   B. Automatic Controls: Tags. Key to control schematic.
   C. Control Panels: Nameplates.
   D. Ductwork: Duct labels.
   F. Instrumentation: Tags.
   G. Major Control Components: Nameplates.
   H. Piping: Pipe markers.
   I. Relays: Tags.
   J. Small-sized Equipment: Tags.
   K. Thermostats: None.
L. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

A. Properly identify each piece of equipment and its controls using engraved laminated plastic descriptive nameplates, attached to equipment and controls using round head brass machine screws, pop rivets or contact cement.

B. Cardholders in any form not acceptable.

C. Content: Minimum information indicating unique equipment tag.

D. Multi-layered metalized polyester with permanent adhesive.
   2. Letter Height: 1 inch (2 mm), minimum.

2.03 TAGS

A. Valve Identification
   1. Provide tags on all control and line shut-off valves. Tags shall note valve service and number as hereinafter specified and shall be Seton Style 250-BL, Brady, or equal, brass tag fastened to the valve stem with copper wire.
   2. Provide three (3) typewritten schedules giving numbers, service and locations, and notations of normally open or closed, of all tagged valves, where purpose of location is not easily identifiable. Enclose each schedule in separate transparent plastic binder. Include locations on as-built drawings.

B. Content: Minimum information indicating unique valve or instrument tag

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

2.04 PIPE MARKERS

A. Identify and color-code all piping including piping in furred ceiling spaces.

B. Provide directional arrows on circulating systems.

C. Identification shall be in accordance with ANSI A13.1-1981, Scheme for Identification of Piping Systems (OSHA) and as specified herein.

D. Plastic Markers: Setmark Type "SNA", Brady or equal. Each marker must show approved color-coded background, proper color of legend in relation to background color, approved legend letter size, approved marker length.

E. Location for Pipe Identification:
   1. Adjacent to each valve and fitting (except on plumbing fixtures and equipment).
   2. At each branch and riser take-off.
   3. At each pipe passage through wall, floor and ceiling construction.
   4. On all horizontal runs spaced 25-feet maximum.

F. Color: Conform to ASME A13.1.

G. Content: Minimum information indicating flow direction arrow and identification of fluid being conveyed.

H. Size:
1. Up to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
2. Over 2 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.

**2.05 DUCT LABELS**


B. Content: Minimum information indicating flow direction arrow and identification of air service.

C. Size: 12 inch long color field (minimum), 2-1/2 inch high letters.

D. Plastic Tape Duct Labels: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

**2.06 SIGNS AND LABELS**

A. Fasten a red-headed tack to each T-bar suspended ceiling push out tile at heating coils, filter changing locations, fire dampers, valves, control devices, etc.

B. A printed sign shall be posted at each automatically started equipment stating," WARNING THIS MACHINE IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME".

**PART 3 EXECUTION**

**3.01 PREPARATION**

A. Degrease and clean surfaces to receive adhesive for identification materials.

**3.02 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. Install plastic pipe markers or plastic tape pipe markers in accordance with manufacturer's instructions.

D. Install ductwork with duct labels.

E. 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.

END OF SECTION 23 05 53
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.
B. Testing, adjustment, and balancing of refrigerating systems.
C. Commissioning activities.

1.02  REFERENCE STANDARDS


1.03  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. 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 to Architect.
   2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   3. Include certification that the plan developer has reviewed the 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.
   4. Include at least the following in the plan:
      a. List of all air 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. Identification and types of measurement instruments to be used and their most recent calibration date.
      d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      e. Final test report forms to be used.
      f. Detailed step-by-step procedures for TAB work for each system and issue, including:
1) Terminal flow calibration (for each terminal type).
2) Diffuser proportioning.
3) Branch/submain proportioning.
4) Total flow calculations.
5) Rechecking.
6) Diversity issues.
g. Details of how TOTAL flow will be determined; for example:
   1) Air: Sum of terminal flows via control system calibrated
      readings or via hood readings of all terminals, supply (SA) and
      return air (RA) pitot traverse, SA or RA flow stations.
h. Confirmation of understanding of the outside air ventilation criteria
   under all conditions.
i. Method of verifying and setting minimum outside air flow rate will
   be verified and set and for what level (total building, zone, etc.).
j. Method of checking building static and exhaust fan and/or relief
   damper capacity.
k. Procedures for formal deficiency reports, including scope, frequency
   and distribution.

C. 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.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 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. NEBB Procedural Standards for Testing Adjusting Balancing of
      Environmental Systems.

B. Begin work after completion of systems to be tested, adjusted, or balanced
   and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems,
   including fire and smoke detection, alarm, and control, coordinate
   scheduling and testing and inspection procedures with the authorities
   having jurisdiction.

D. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of
      systems specified in this section.
   2. Having minimum of three years documented experience.
3. Certified by one of the following:

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 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.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 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. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. 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.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.07 COMMISSIONING

A. See Sections 01 91 13 and 23 08 00 for additional requirements.

B. Perform prerequisites prior to starting commissioning activities.
C. Fill out Prefunctional Checklists for:
   1. Air side systems.

D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.

E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 100 percent of the air handlers plus a random sample equivalent to 100 percent of the final TAB report data as directed by Commissioning Authority.
   1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
   2. Use the same test instruments as used in the original TAB work.
   3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
   4. For purposes of re-check, failure is defined as follows:
      a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
      b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
      c. Temperatures: Deviation of more than one degree F (0.5 degree C).
      d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
      e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
   5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.

F. In the presence of the Commissioning Authority, verify that:
   1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
   2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

END OF SECTION 23 05 93
SECTION 23 07 13

DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.
B. Duct Liner.
C. Insulation jackets.

1.02 RELATED REQUIREMENTS

A. Section 23 05 53 - Identification for HVAC Piping and Equipment.
B. Section 23 31 00 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

M. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
1.04 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.

1.05 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.

1.06 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.

1.07 FIELD CONDITIONS
A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS
2.01 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.

2.02 GLASS FIBER, FLEXIBLE
A. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. 'K' ('Ksi') value (maximum): 0.27 at 75 degrees F (____ at 24 degrees C), when tested in accordance with ASTM C518.
   2. Density: 0.75 lbs/cu. ft. (nominal)
   4. Maximum Water Vapor Absorption: 5.0 percent by weight.
B. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film ('FSK') or White kraft paper with glass fiber yarn ('PSK').
   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.

2.03 GLASS FIBER, RIGID
A. Insulation: ASTM C612; rigid, noncombustible blanket.
   1. 'K' ('Ksi') Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.
   3. Maximum Water Vapor Absorption: 5.0 percent.
   4. Maximum Density: 8.0 lb/cu ft (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.

D. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 JACKETS

1. Thickness: 0.016 inch (0.40 mm) sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
4. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

2.05 DUCT LINER

A. Manufacturers:
1. Ductmate Industries, Inc. (PolyArmor polyester duct liner)
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: Non-corrosive, incombustible polyester fiber complying with ASTM C1071 and ASTM E84; webbed into a thermal blanket which is then bonded with a FSK Facing.
1. Fungal Resistance: No growth when tested according to ASTM G21.
2. Thermal Resistance at 75 degrees F per ASTM C518:
   a. 1-inch Thickness: R-5
   b. 1-1/2 inch Thickness: R-6
   c. 2-inch Thickness: R-8
3. Service Temperature: Up to 250 degrees F (121 degrees C).
4. Minimum Noise Reduction Coefficients:
   a. 1 inch (25 mm) Thickness: 0.65.
   b. 1-1/2 inches (40 mm) Thickness: 0.65.
   c. 2 inch (50 mm) Thickness: 0.65.

C. Adhesive: Waterproof, fire-retardant type, ASTM C916.

D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. 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.

D. Insulated ducts conveying air above ambient temperature:
1. Provide with or without standard vapor barrier jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor) ((below 3 meters above finished floor)): Finish with canvas jacket sized for finish painting.

F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with aluminum jacket.

G. External Duct Insulation Application:
1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
2. Secure insulation without vapor barrier with staples, tape, or wires.
3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

H. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES
A. Refer to Drawings for Duct Insulation Schedule.

END OF SECTION 23 07 13
SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.
B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 07 84 00 - Firestopping.
C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

1.04 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.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.
B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 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.

2.02 GLASS FIBER

A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. 'K' ('Ksi') Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
   3. Maximum Moisture Absorption: 0.2 percent by volume.

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
   1. 'K' ('Ksi') Value: ASTM C177, 0.23 at 75 degrees F (0.034 at 24 degrees C).
   3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
   1. Maximum Service Temperature: 650 degrees F (343 degrees C).
   2. 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-inches (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.
2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 3; use molded tubular material wherever possible.
   1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.04 JACKETS

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 (0.25 mm).
      e. Connections: Brush on welding adhesive.
   2. Covering Adhesive Mastic: Compatible with insulation.

B. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
   1. Thickness: 0.010 inch (0.25 mm).
   2. Finish: Smooth.
   3. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
E. 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.
F. 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.

G. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.

H. 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.

I. 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.

J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with PVC jacket and fitting covers.

L. 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.

END OF SECTION 23 07 19
COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY

A. See Section 01 91 13 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 91 13.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:

1. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 REFERENCE STANDARDS


1.03 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. DRAFT Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:

1. System name.
2. List of devices.
3. Step-by-step procedures for testing each controller after installation, including:
   a. Process of verifying proper hardware and wiring installation.
   b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
   c. Process of performing operational checks of each controlled component.
   d. Plan and process for calibrating valve and damper actuators and all sensors.
e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.

5. Description of the instrumentation required for testing.

6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.

C. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.

D. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:

1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.

2. Full as-built set of control drawings.

3. Full as-built sequence of operations for each piece of equipment.

4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
   a. Floor.
   b. Room number.
   c. Room name.
   d. Air handler unit ID.
   e. Reference drawing number.
   f. Air terminal unit tag ID.
   g. Heating and/or cooling valve tag ID.
   h. Minimum air flow rate.
   i. Maximum air flow rate.

5. Full print out of all schedules and set points after testing and acceptance of the system.

6. Full as-built print out of software program.

7. Electronic copy on disk of the entire program for this facility.

8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.

9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.

10. Control equipment component submittals, parts lists, etc.

11. Warranty requirements.

12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).

13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
   a. Sequences of operation.
   b. Control drawings.
   c. Points lists.
   d. Controller and/or module data.
e. Thermostats and timers.
f. Sensors and DP switches.
g. Valves and valve actuators.
h. Dampers and damper actuators.
i. Program setups (software program printouts).

E. Project Record Documents: See Section 01 78 00 for additional requirements.
1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.

F. Draft Training Plan: In addition to requirements specified in Section 01 79 00, include:
1. Follow the recommendations of ASHRAE Guideline 1.1.
2. Control system manufacturer’s recommended training.
3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.

G. Training Manuals: See Section 01 79 00 for additional requirements.
1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 PREPARATION

A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Authority.

C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.

D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the
scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.

G. Provide temperature and pressure taps in accordance with the contract documents.

3.02 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

E. Isolation Valve or System Valve Leak Check: For valves not by coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing of HVAC.

B. Coordinate commissioning schedule with TAB schedule.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.

E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.

F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.
3.04 CONTROL SYSTEM FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of the Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with the contract documents.

C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.

D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
   1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
   2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.

E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

G. Demonstrate to the Commissioning Authority:
   1. That all specified functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and setup, including holidays.
   3. That all graphic screens and value readouts are completed.
   4. Correct date and time setting in central computer.
   5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
   6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
   7. Power failure and battery backup and power-up restart functions.
   8. Global commands features.
   9. Security and access codes.
   10. Occupant over-rides (manual, telephone, key, keypad, etc.).
   11. O&M schedules and alarms.
   12. Occupancy sensors and controls.
   13. All control strategies and sequences not tested during controlled equipment testing.
H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

A. See Section 01 78 00 for additional requirements.

B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.

C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 01 79 00 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner's personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.

D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:

E. TAB Review: Instruct Owner's personnel for minimum 20 hours, after completion of TAB, on the following:
   1. Review final TAB report, explaining the layout and meanings of each data type.
   2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
   3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
   4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
   5. Other salient information that may be useful for facility operations, relative to TAB.

F. HVAC Control System Training: Perform training in at least three phases:
   1. Phase 1 - Basic Control System: Provide minimum of 40 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
      a. This training may be held on-site or at the manufacturer's facility.
b. If held off-site, the training may occur prior to final completion of the system installation.

c. For off-site training, Contractor shall pay expenses of up to two attendees.

2. Phase 2 - Integrating with HVAC Systems: Provide minimum of 24 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
   a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
   b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
   c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
   d. Every display screen, allowing time for questions.
   e. Point database entry and modifications.

3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of 12 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.

G. Provide the services of manufacturer representatives to assist instructors where necessary.

H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION 23 08 00
SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air supply system.
B. Thermostats.
C. Control valves.
D. Automatic dampers.
E. Damper operators.

1.02 RELATED REQUIREMENTS

A. Section 22 05 19 - Meters and Gages for Plumbing Piping: Thermometer sockets, gage taps.
B. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
C. Section 23 05 19 - Meters and Gages for HVAC Piping: Thermometer sockets, gage taps.
D. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
E. Section 23 09 23 - Direct-Digital Control System for HVAC.
F. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
E. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
I. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats; 2013.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

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

B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Samples: Submit two of each type of room thermostat and cover.

E. Design Data: Provide design data for sizing and selection of compressor.

F. Manufacturer’s Instructions: Provide for all manufactured components.

G. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

H. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum 10 years experience approved by manufacturer.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
2.02 CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.

B. NEMA 250, general purpose utility enclosures with enamelled finished face panel.

C. Provide common keying for all panels.

2.03 CONTROL VALVES

A. Globe Pattern:
   1. Over 2 inches (50 mm): Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
   2. Hydronic Systems:
      a. Rate for service pressure of 125 psig at 250 degrees F (860 kPa at 121 degrees C).
      b. Replaceable plugs and seats of stainless steel.
      c. Size for 3 psig (20 kPa) maximum pressure drop at design flow rate.
      d. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.

B. Electronic Operators:
   1. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
   2. Select operator for full shut off at maximum pump differential pressure.

2.04 DAMPERS

A. Performance: Test in accordance with AMCA 500-D.

B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage, 0.1046 inch (2.66 mm).

C. Blades: Galvanized steel, maximum blade size 8 inches (200 mm) wide, 48 inches (1200 mm) long, minimum 22 gage, 0.0299 inch (0.76 mm), attached to minimum 1/2 inch (13 mm) shafts with set screws.

D. Blade Seals: Synthetic elastomeric inflatable mechanically attached, field replaceable.

E. Jamb Seals: Spring stainless steel.

2.05 DAMPER OPERATORS

A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

B. Electric Operators:
   1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.06 INPUT/OUTPUT SENSORS

A. Temperature Sensors:
   1. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F (26 degrees C).
2. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
3. Temperature sensing device must be compatible with project DDC controllers.
4. Performance Characteristics:
   a. RTD:
      1) Room Sensor Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
      2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
      3) All Other Accuracy: Plus/minus 0.75 degrees F (0.42 degrees C) minimum.
   b. Room Sensors: Locking cover matching the pneumatic thermostats used.
   c. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
   d. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
   e. Ceiling and Recessed Mount Temperature Sensors: Ceiling-mounted sensor in a low-profile housing.
   f. Room Temperature Sensors:
   g. Room Temperature Sensors with Integral Digital Display:
      1) Construct for surface or wall box.
      2) Provide a four button keypad with the following capabilities:

2.07 THERMOSTATS

A. Electric Room Thermostats:
   1. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
   2. Service: Cooling only.
   3. Covers: Locking with set point adjustment, with thermometer.

B. Line Voltage Thermostats:
   1. Integral manual On/Off/Auto selector switch, single or two pole as required.
   2. Dead band: Maximum 2 degrees F (one degree C).
   3. Cover: Locking with set point adjustment, with thermometer.

C. Room Thermostat Accessories:

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that systems are ready to receive work.
C. Beginning of installation means installer accepts existing conditions.
D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
F. Ensure installation of components is complementary to installation of similar components.
G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches (1500 mm) above floor. Align with lighting switches and humidistats. Refer to Section 26 27 26.

C. Mount freeze protection thermostats using flanges and element holders.

D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

E. Provide valves with position indicators and with pilot positioners where sequenced with other controls.

F. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

G. Provide isolation (two position) dampers of parallel blade construction.

H. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

I. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

J. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

END OF SECTION 23 09 13
PART 1  GENERAL

1.01  SECTION INCLUDES
A. System description.
B. Operator interface.
C. Controllers.
D. Power supplies and line filtering.
E. System software.
F. Controller software.
G. HVAC control programs.

1.02  RELATED REQUIREMENTS
A. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
B. Section 23 09 93 - Sequence of Operations for HVAC Controls.
C. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.
D. Section 28 31 00 - Fire Detection and Alarm.

1.03  REFERENCE STANDARDS
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04  ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data for each system component and software module.
C. Shop Drawings:
   1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration diskette containing graphics.
3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
4. Indicate description and sequence of operation of operating, user, and application software.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

F. Operation and Maintenance Data:
   1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
   2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
   3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
   1. Limiting use of software to equipment provided under these specifications.
   2. Limiting copying.
   3. Preserving confidentiality.
   4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Andover Continuum by Scheider Electric Campus Standard No Exceptions.

2.02 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.03 OPERATOR INTERFACE

A. PC Based Work Station:

B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.

C. Hardware:

2.04 CONTROLLERS

A. BUILDING CONTROLLERS

1. General:
   a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
   b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
   c. Share data between networked controllers.
   d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
   e. Utilize real-time clock for scheduling.
   f. Continuously check processor status and memory circuits for abnormal operation.
   g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
   h. Communication with other network devices to be based on assigned protocol.

2. Communication:
   a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
   b. Perform routing when connected to a network of custom application and application specific controllers.
   c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F (4 to 65 degrees C).
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

4. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet (1 m).

B. CUSTOM APPLICATION CONTROLLERS
   1. General:
      a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
      b. Share data between networked, microprocessor based controllers.
      c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
      d. Utilize real-time clock for scheduling.
      e. Continuously check processor status and memory circuits for abnormal operation.
      f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
      g. Communication with other network devices to be based on assigned protocol.
   2. Communication:
      a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
      b. Provide service communication port for connection to a portable operator's terminal or handheld device with compatible protocol.
   3. Anticipated Environmental Ambient Conditions:
      a. Outdoors and/or in Wet Ambient Conditions:
         1) Mount within waterproof enclosures.
         2) Rated for operation at 40 to 150 degrees F (4 to 65 degrees C).
      b. Conditioned Space:
         1) Mount within dustproof enclosures.
         2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
   4. Provisions for Serviceability:
      a. Diagnostic LED’s for power, communication, and processor.
      b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
   5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
   6. Power and Noise Immunity:
      a. Maintain operation at 90 to 110 percent of nominal voltage rating.
      b. Perform orderly shutdown below 80 percent of nominal voltage.
      c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet (1 m).

C. APPLICATION SPECIFIC CONTROLLERS
   1. General:
      a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
      b. Customized for operation within the confines of equipment served.
c. Communication with other network devices to be based on assigned protocol.

2. Communication:
   a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
   b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F (4 to 65 degrees C).
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

4. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet (1 m).

D. INPUT/OUTPUT INTERFACE
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.

2. All Input/Output Points:
   a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
   b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.

3. Binary Inputs:
   a. Allow monitoring of On/Off signals from remote devices.
   b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
   c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.

5. Analog Inputs:
   a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
   b. Compatible with and field configurable to commonly available sensing devices.

6. Binary Outputs:
   a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
b. Outputs provided with three position (On/Off/Auto) override switches.
c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
   a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
   b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
   c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
   a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
   b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
   c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
   a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
   b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.05 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:
   1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
   2. Limit connected loads to 80 percent of rated capacity.
   3. Match DC power supply to current output and voltage requirements.
   4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
   5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
   6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
   7. Operational Ambient Conditions: 32 to 120 degrees F (0 to 50 degrees C).
   8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
   9. Line voltage units UL recognized and CSA approved.
B. Power Line Filtering:
   1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
   2. Minimum surge protection attributes:
      a. Dielectric strength of 1000 volts minimum.
      b. Response time of 10 nanoseconds or less.
      c. Transverse mode noise attenuation of 65 dB or greater.
      d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.
2.06 LOCAL AREA NETWORK (LAN)

A. Provide communication between control units over local area network (LAN).

B. LAN Capacity: Not less than 60 stations or nodes.

C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.

D. LAN Data Speed: Minimum 19.2 Kb.

E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

F. Transmission Median: Fiber optic or single pair of solid 24 gage twisted, shielded copper cable.

G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.07 SYSTEM SOFTWARE

A. Operating System:
   1. Concurrent, multi-tasking capability.

2. System Graphics:
   a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
   b. Animation displayed by shifting image files based on object status.
   c. Provide method for operator with password to perform the following:
      1) Move between, change size, and change location of graphic displays.
      2) Modify on-line.
      3) Add, delete, or change dynamic objects consisting of:
         (a) Analog and binary values.
         (b) Dynamic text.
         (c) Static text.
         (d) Animation files.

3. Custom Graphics Generation Package:
   a. Create, modify, and save graphic files and visio format graphics in PCX formats.
   b. HTML graphics to support web browser compatible formats.
   c. Capture or convert graphics from AutoCAD.

4. Standard HVAC Graphics Library:
   a. HVAC Equipment:
   b. Ancillary Equipment:

B. Workstation System Applications:
   1. Automatic System Database Save and Restore Functions:
   a. Current database copy of each Building Controller is automatically stored on hard disk.
   b. Automatic update occurs upon change in any system panel.
c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.

2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
   a. Save database from any system panel.
   b. Clear a panel database.
   c. Initiate a download of a specified database to any system panel.

3. Software provided allows system configuration and future changes or additions by operators under proper password protection.

4. On-line Help:
   a. Context-sensitive system assists operator in operation and editing.
   b. Available for all applications.
   c. Relevant screen data provided for particular screen display.
   d. Additional help available via hypertext.

5. Security:
   a. Operator log-on requires user name and password to view, edit, add, or delete data.
   b. System security selectable for each operator.
   c. System supervisor sets passwords and security levels for all other operators.
   d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
   e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
   f. All system security data stored in encrypted format.

6. System Diagnostics:
   a. Operations Automatically Monitored:
      1) Workstations.
      2) Printers.
      3) Modems.
      4) Network connections.
      5) Building management panels.
      6) Controllers.
   b. Device failure is annunciated to the operator.

7. Alarm Processing:
   a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
   b. Configurable Objects:
      1) Alarm limits.
      2) Alarm limit differentials.
      3) States.
      4) Reactions for each object.

8. Alarm Messages:
   b. Recognizable Features:
      1) Source.
      2) Location.
      3) Nature.

9. Configurable Alarm Reactions by Workstation and Time of Day:
   a. Logging.
   b. Printing.
   c. Starting programs.
   d. Displaying messages.
   e. Dialing out to remote locations.
f. Paging.
g. Providing audible annunciation.
h. Displaying specific system graphics.

10. Custom Trend Logs:
   a. Definable for any data object in the system including interval, start time, and stop time.
   b. Trend Data:
      1) Sampled and stored on the building controller panel.
      2) Archivable on hard disk.
      3) Retrievable for use in reports, spreadsheets and standard database programs.
      4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
      5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.

11. Alarm and Event Log:
   a. View all system alarms and change of states from any system location.
   b. Events listed chronologically.
   c. Operator with proper security acknowledges and clears alarms.
   d. Alarms not cleared by operator are archived to the workstation hard disk.

12. Object, Property Status and Control:
   a. Provide a method to view, edit if applicable, the status of any object and property in the system.
   b. Status Available by the Following Methods:
      1) Menu.
      2) Graphics.
      3) Custom Programs.

13. Reports and Logs:
   a. Reporting Package:
      1) Allows operator to select, modify, or create reports.
      2) Definable as to data content, format, interval, and date.
      3) Archivable to hard disk.
   b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
   c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
   d. Set to be printed on operator command or specific time(s).

14. Reports:
   a. Standard:
      1) Objects with current values.
      2) Current alarms not locked out.
      3) Disabled and overridden objects, points and SNVTs.
      4) Objects in manual or automatic alarm lockout.
      5) Objects in alarm lockout currently in alarm.
      6) Logs:
         (a) Alarm History.
         (b) System messages.
         (c) System events.
         (d) Trends.
   b. Custom:
      1) Daily.
      2) Weekly.
      3) Monthly.
4) Annual.
5) Time and date stamped.
6) Title.
7) Facility name.
c. Tenant Override:
   1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
   2) Annual report showing override usage on a monthly basis.
d. Electrical, Fuel, and Weather:
   1) Electrical Meter(s):
      (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
      (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
   2) Fuel Meter(s):
      (a) Monthly showing daily natural gas consumption for each meter.
      (b) Annual summary showing monthly consumption for each meter.
   3) Weather:
      (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

C. Workstation Applications Editors:
   1. Provide editing software for each system application at PC workstation.
   2. Downloaded application is executed at controller panel.
   3. Full screen editor for each application allows operator to view and change:
      a. Configuration.
      b. Name.
      c. Control parameters.
      d. Set-points.
   4. Scheduling:
      a. Monthly calendar indicates schedules, holidays, and exceptions.
      b. Allows several related objects to be scheduled and copied to other objects or dates.
      c. Start and stop times adjustable from master schedule.
   5. Custom Application Programming:
      a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
      b. Programming Features:
         1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
         2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
         3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
         4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.

6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.

8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.

9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.08 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

B. System Security:
   1. User access secured via user passwords and user names.
   2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
   3. User Log On/Log Off attempts are recorded.
   4. Automatic Log Off occurs following the last keystroke after a user defined delay time.

C. Object or Object Group Scheduling:
   1. Weekly Schedules Based on Separate, Daily Schedules:
      a. Include start, stop, optimal stop, and night economizer.
      b. 10 events maximum per schedule.
      c. Start/stop times adjustable for each group object.

D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

E. Alarms:
   1. Binary object is set to alarm based on the operator specified state.
   2. Analog object to have high/low alarm limits.
   3. All alarming is capable of being automatically and manually disabled.
   4. Alarm Reporting:
      a. Operator determines action to be taken for alarm event.
      b. Alarms to be routed to appropriate workstation.
      c. Reporting Options:

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

G. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.

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H. PID Control Characteristics:
   1. Direct or reverse action.
   2. Anti-windup.
   3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.

I. Staggered Start Application:
   1. Prevents all controlled equipment from simultaneously restarting after power outage.
   2. Order of equipment startup is user selectable.

J. Energy Calculations:
   1. Accumulated instantaneous power or flow rates are converted to energy use data.
   2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
   3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.

K. Anti-Short Cycling:
   1. All binary output objects protected from short-cycling.
   2. Allows minimum on-time and off-time to be selected.

L. On-Off Control with Differential:
   1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
   2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

M. Run-Time Totalization:
   1. Totalize run-times for all binary input objects.
   2. Provides operator with capability to assign high run-time alarm.

2.09 HVAC CONTROL PROGRAMS

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

C. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.
3.03 MANUFACTURER'S FIELD SERVICES
   A. Start and commission systems. Allow sufficient time for start-up and
      commissioning prior to placing control systems in permanent operation.

3.04 DEMONSTRATION AND INSTRUCTIONS
   A. Demonstrate complete and operating system to Owner.

3.05 MAINTENANCE
   A. Provide service and maintenance of energy management and control
      systems for one year from Date of Substantial Completion.
   B. Provide two complete inspections, one in each season, to inspect, calibrate,
      and adjust controls as required, and submit written reports.
   C. Provide complete service of systems, including call backs. Make minimum
      of 5 complete normal inspections of approximately 8 hours duration in
      addition to normal service calls to inspect, calibrate, and adjust controls,
      and submit written reports.

END OF SECTION 23 09 23
SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Hydronic system requirements.
B. Heating water piping, buried.
C. Heating water and glycol piping, buried.
D. Heating water piping, above grade.
E. Heating water and glycol piping, above grade.
F. Equipment drains and overflows.
G. Pipe hangers and supports.
H. Unions, flanges, mechanical couplings, and dielectric connections.
I. Valves:
   1. Ball valves.
   2. Butterfly valves.
   3. Check valves.

1.02 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 08 31 00 - Access Doors and Panels.
C. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
D. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
E. Section 23 05 53 - Identification for HVAC Piping and Equipment.
F. Section 23 07 19 - HVAC Piping Insulation.
G. Section 23 21 14 - Hydronic Specialties.
H. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS
B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
D. ASME B31.9 - Building Services Piping; 2014.


I. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.


L. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.

M. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; 2011 and errata.


P. AWWA C606 - Grooved and Shouldered Joints; 2011.


1.04 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 catalogue information.
   3. Indicate valve data and ratings.
   4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

C. Manufacturer’s Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Project Record Documents: Record actual locations of valves.

E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 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

2.01 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.

2.02 HEATING WATER AND GLYCOL PIPING, BURIED

A. Steel Pipe: ASTM A53/A53M, Schedule 80, black, with AWWA C105/A21.5 polyethylene jacket, or double layer, half-lapped polyethylene tape.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), annealed.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP copper/silver alloy.
   3. Casing: Closed glass cell insulation.

2.03 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
      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.
      c. Braze: 1 BCuP copper/silver alloy.
2.04 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type M (C), drawn; using one of the following joint types:

2.05 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 Inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
   3. Hangers for Hot Pipe Sizes 2 to 4 Inches (50 to 100 mm): Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches (150 mm) and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
   6. Wall Support for Pipe Sizes to 3 Inches (76 mm): Cast iron hook.
   7. Wall Support for Pipe Sizes 4 Inches (100 mm) and Greater: Welded steel bracket and wrought steel clamp.
   8. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
   10. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   11. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   12. 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.

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.

2.06 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches (50 mm) and Less:

B. Flanges for Pipe 2 Inches (50 mm) and Greater:

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.
   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.

2.07 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.

2.08 BUTTERFLY VALVES
A. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
B. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
C. Operator: 10 position lever handle.

2.09 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 trim, stainless steel, bronze, or bronze faced rotating swing disc, renewable disc and seat, flanged or grooved ends.

2.10 SPRING LOADED CHECK VALVES
A. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

PART 3 EXECUTION
3.01 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. Refer to Section 23 25 00 for additional requirements.

3.02 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 interfere with use of space.
D. Group piping whenever practical at common elevations.
E. Slope piping and arrange to drain at low points.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

H. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

I. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
   2. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
   3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   4. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.

J. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00.

K. Install valves with stems upright or horizontal, not inverted.

END OF SECTION 23 21 13
SECTION 23 21 14

HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Expansion tanks.
B. Air vents.
C. Air separators.
D. Strainers.
E. Suction diffusers.
F. Pressure-temperature test plugs.
G. Balancing valves.
H. Combination flow controls.
I. Flow meters.
J. Relief valves.
K. Pressure reducing valves.

1.02 RELATED REQUIREMENTS

A. Section 22 10 06 - Plumbing Piping Specialties: Backflow preventers.
B. Section 23 21 13 - Hydronic Piping.
C. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.

1.04 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.

1.05 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

2.01 EXPANSION TANKS

A. 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 or bladder sealed into tank, and steel support stand.

B. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi (80 kPa).

C. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.

B. Float Type:
   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.
   2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

C. Washer Type:
   1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.03 AIR SEPARATORS

A. Coalescing Air/Dirt Separators:
   1. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1; for 150 psi (1034 kPa) operating pressure and 270 degrees F (132 degrees C) maximum operating temperature; subject to the requirements of the application and the manufacturer's standard maximum operating conditions.
   2. Coalescing Medium: Provide structured copper or stainless steel medium filling 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.
   3. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi (1030 kPa), threaded to the top of the separator.
   4. Inlet and Outlet Connections: Threaded for 2 NPS (50 DN) and smaller; Class 150 flanged connections for 2-1/2 NPS (65 DN) and larger.
   5. Blowdown Connection: Threaded.

2.04 STRAINERS

A. Size 2 inch (50 mm) and Under:
   1. Screwed brass or iron body for 175 psi (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
B. Size 2-1/2 inch (65 mm) to 4 inch (100 mm):
   1. Provide flanged or grooved iron body for 175 psi (1200 kPa) working pressure, Y pattern with 1/16 inch (1.6 mm), or 3/64 inch (1.2 mm) stainless steel perforated screen.

2.05 SUCTION DIFFUSERS
A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch (50 mm) and smaller, flanged for 2-1/2 inch (65 mm) and larger, rated for 175 psi (1200 kPa) working pressure, with inlet vanes, cylinder strainer with 3/16 inch (5 mm) diameter openings, disposable 5/32 inch (4 mm) mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.

2.06 PRESSURE-TEMPERATURE TEST PLUGS
A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F (93 degrees C).
B. Application: Use extended length plugs to clear insulated piping.

2.07 BALANCING VALVES
A. Size 2 inch (50 mm) and Smaller:
   1. Provide ball style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
   2. Metal construction materials consist of bronze or brass.
   3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
B. Size 2.5 inch (64 mm) and Larger:
   1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
   2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
   3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.08 COMBINATION FLOW CONTROLS
A. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi (24 kPa).
C. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.

2.09 FLOW METERS

2.10 RELIEF VALVES
A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.
2.11 PRESSURE REDUCING VALVES

A. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 21 13.

B. Materials of Construction:
   1. Valve Body: Constructed of bronze, cast iron, brass, or iron.
   2. Internal Components: Construct of stainless steel or brass and engineered plastics or composition material.

C. Connections:
   1. NPT threaded: 0.50 inch (15 mm), or 0.75 inch (20 mm).
   2. Soldered: 0.50 inch (15 mm).

D. Provide integral check valve and strainer.

E. Maximum Inlet Pressure: 100 psi (689 kPa).

F. Maximum Fluid Temperature: 180 degrees F (82 degrees C).

G. Operating Pressure Range: Between 10 psi (69 kPa) and 25 psi (172 kPa).

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Where large air quantities can accumulate, provide enlarged air collection standpipes.

C. Provide manual air vents at system high points and as indicated.

D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

E. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.

F. Provide radiator balancing valves on water outlet from terminal heating units such as radiation, unit heaters, and fan coil units.

G. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

H. 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.

I. Pipe relief valve outlet to nearest floor drain.

3.02 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

1.01 SECTION INCLUDES

A. System lubricated circulators.
B. Vertical in-line pumps.

1.02 RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 07 16 - HVAC Equipment Insulation.
C. Section 23 21 13 - Hydronic Piping.
D. Section 23 21 14 - Hydronic Specialties.
E. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. NEMA MG 1 - Motors and Generators; 2014.
B. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 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.
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 Pump Seals: One set for each type and size of pump.
PART 2 PRODUCTS

2.01 MANUFACTURERS
B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com.
C. TACO.

2.02 HVAC PUMPS - 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. Minimum Quality Standard: UL 778.
C. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.03 SYSTEM LUBRICATED CIRCULATORS
A. Type: 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.

2.04 VERTICAL IN-LINE PUMPS
A. Type: Vertical, single stage, split coupled, radially or horizontally split casing, for in-line mounting, for 175 psi (1200 kPa) working pressure.
B. Casing: Cast iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
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. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 250 degrees F (121 degrees C) maximum continuous operating temperature.

PART 3 EXECUTION

3.01 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. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
D. Provide drains for bases and seals, piped to and discharging into floor drains.

END OF SECTION 23 21 23
HYDRONIC PUMPS

23 21 23 - 4
SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Materials.
   1. System cleaner.
   2. Closed system treatment (water).

B. By-pass (pot) feeder.

C. Drip feeder.

D. Solution metering pump.

E. Water meter.

F. Solenoid valves.

G. Timers.

H. Test equipment.

1.02 RELATED REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Owner furnished treatment equipment.

B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.

C. Section 23 21 13 - Hydronic Piping.

D. Section 23 21 14 - Hydronic Specialties.

E. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 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. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

F. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

G. 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.

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.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum _____ years of experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MATERIALS

A. System Cleaner:
   1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
   2. 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):
   1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
   2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
   3. Conductivity enhancers; phosphates or phosphonates.

2.02 BY-PASS (POT) FEEDER

A. Manufacturers:

B. 2 quart (1.9 L) quick opening cap for working pressure of 175 psi (1200 kPa).

2.03 SOLUTION METERING PUMP

A. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.

B. Electrical Characteristics:
   1. 120 volts, single phase, 60 Hz.
   2. Cord and Plug: Provide unit with 6 foot (2 m) cord and plug for connection to electric wiring system including grounding connector.
2.04 SOLENOID VALVES
   A. Forged brass body globe pattern, normally open or closed as required, explosion-proof and watertight solenoid enclosure, and continuous duty coil.

2.05 TIMERS
   A. Electronic timers, infinitely adjustable over full range, 150 second and five minute range, mounted together in cabinet with hands-off-automatic switches and status lights.

2.06 TEST EQUIPMENT
   A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
   B. Provide the following test kits:
      1. Alkalinity titration test kit.
      2. Chloride titration test kit.
      3. Sulphite titration test kit.
      4. Total hardness titration test kit.
      5. Low phosphate test kit.
      6. Conductivity bridge, range 0 - 10,000 micro-ohms.
      7. Creosol red pH slide complete with reagent.
      8. Portable electronic conductivity meter.
      9. High nitrite test kit.

PART 3 EXECUTION

3.01 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.

3.02 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. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
   D. Remove, clean, and replace strainer screens.
   E. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
3.03 INSTALLATION
   A. Install in accordance with manufacturer’s instructions.

3.04 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.

3.05 CLOSEOUT ACTIVITIES
   A. Training: Train Owner’s personnel on operation and maintenance of chemical treatment system.
      1. Provide minimum of two hours 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.

3.06 MAINTENANCE
   A. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.
   B. Provide service and maintenance of treatment systems for 3 years from Date of Substantial Completion.
   C. 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.
   D. Provide laboratory and technical assistance services during this maintenance period.
   E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION 23 25 00
SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal ductwork.
B. Casing and plenums.
C. Kitchen hood ductwork.
D. Duct cleaning.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
C. Section 23 33 00 - Air Duct Accessories.
D. Section 23 37 00 - Air Outlets and Inlets.
E. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCE STANDARDS

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.04 SUBMITTALS

A. See Section 01 3000 - Submittal Procedures, for submittal procedures.
B. Product Data: Provide data for duct materials.
C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for 2 in wg pressure class and higher systems.
D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).
1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
   B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum ___ years of documented experience.

1.06 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

2.01 DUCT ASSEMBLIES
   A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.
   B. Ducts: Galvanized steel, unless otherwise indicated.
   C. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. (125 Pa) pressure class, galvanized steel.
   D. Return and Relief: 1/2 inch w.g. (125 Pa) pressure class, galvanized steel.
   E. General Exhaust: 1/2 inch w.g. (125 Pa) pressure class, galvanized steel.
   F. Kitchen Cooking Hood Exhaust: 1/2 inch w.g. (125 Pa) pressure class, galvanized steel.
      1. Pre-fabricated single-wall grease duct for use with Type 1 kitchen hoods.
         a. 0.047 thick stainless steel; supports, fan plate adaptor, hood connections, fittings and expansion joint required shall be included
         b. Grease duct joints to be held together by means of formed vee clamps and sealed with 3M Fire Barrier 2000+
         c. UL and ETL listed
         d. Manufacturers:
            1) CaptiveAire
            2) Ampco
      2. Access Doors:
         a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
         b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.
   G. Outside Air Intake: 1/2 inch w.g. (125 Pa) pressure class, galvanized steel.

2.02 MATERIALS
   A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
   B. Stainless Steel for Ducts: ASTM A666, Type 304.
   C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
1. 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.
2. VOC Content: Not more than 250 g/L, excluding water.
3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.

D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   1. Concrete Wedge Expansion Anchors: As indicated on Structural Drawings.
   2. Concrete Screw Type Anchors: As indicated on Structural Drawings.
   3. Concrete Adhesive Type Anchors: As indicated on Structural Drawings.
   4. Other Types: As required.

2.03 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
C. Construct T’s, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
D. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
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. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
G. 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.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

A. Flexible Ducts: Two ply vinyl, polyethylene, or nylon film supported by helically wound spring steel wire.
   1. Insulation: Fiberglass insulation with aluminized vapor barrier film.
   2. Pressure Rating: 2 inches WG (___ kPa) positive and 0.5 inches WG (___ Pa) negative.
   3. Maximum Velocity: 4000 fpm (20.3 m/sec).
   4. Temperature Range: Minus 10 degrees F to 160 degrees F (Minus 23 degrees C to 71 degrees C).
   5. Manufacturers:
      a. Casco.
      b. Flexmaster, Type 1M or Type 6M.
      c. Substitutions: See Section 01 60 00 - Product Requirements.
2.05 CASINGS

A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.

B. Mount floor mounted casings on 4 inch (100 mm) high concrete curbs. At floor, rivet panels on 8 inch (200 mm) centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gage, 0.0478 inch (1.21 mm) expanded metal mesh supported at 12 inch (300 mm) centers, turned up 12 inches (300 mm) at sides with sheet metal shields.

C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. Flexible Ducts: Connect to metal ducts with adhesive.

E. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.

F. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

G. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

I. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

3.02 CLEANING

A. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

END OF SECTION 23 31 00
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Air turning devices/extractors.
B. Backdraft dampers - metal.
C. Combination fire and smoke dampers.
D. Duct access doors.
E. Duct test holes.
F. Flexible duct connections.
G. Manual volume control dampers.
H. Remote actuated volume control dampers.

1.02 RELATED REQUIREMENTS
A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 31 00 - HVAC Ducts and Casings.
C. Section 23 36 00 - Air Terminal Units: Pressure regulating damper assemblies.

1.03 REFERENCE STANDARDS
B. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association
E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
F. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.

C. Manufacturer’s Installation Instructions: Provide instructions for fire dampers.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Comply with NFPA 90A and NFPA 90B.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL

A. Gravity Backdraft Dampers, Size 18 by 18 inches (450 by 450 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer’s standard construction.

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.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   2. Greenheck
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Ratings:
   1. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
   2. Fire Rating: 1-1/2 hours or 3-hours in accordance with UL-555.
   3. Smoke Rating: Class-2 (20 cfm/sf at 4 in wg) leakage in accordance with UL-555S

C. Provide factory sleeve and collar for each damper.

D. Construction:
1. Frame: Hat-shaped channel, roll formed galvanized steel with interlocking gusseted corners. Structurally equivalent to 13 gauge (2.3mm) U-channel type frame. Low profile head and sill on sizes less than 13 inches (330 mm) high.
2. Blades: 6 inch maximum width x 16 gauge (152mm x 1.6mm), 3-V shape, roll formed galvanized steel.
5. Axels: Minimum ½” (13mm) diameter plated steel hex-shaped, mechanically attached to blade.
7. Linkage: Concealed in frame.
8. Fire Closure Device: Resettable
9. Release Temperature: 165 F
10. Mounting: Vertical and/or Horizontal (1 ½ hour rated only)
11. Sleeve: Standard 16 inches long x 20 gauge (406mm x 1.0mm), factory installed.
12. Actuator: Electric 120 V, 60 Hz, two-position, fail close, external mount

E. Position Indicator Switch Package: Shall connect directly to the blade axel for positive annunciation (interconnecting arms, wire-forms, or brackets shall not be accepted) and provide full open and full closed blade indication to a remote location.

F. Damper shall be controlled by area wide smoke and fire detection and alarm system. Coordinate with Section 283000 "Fire Alarm System"

2.04 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

2.05 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.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.06 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. 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 per sq yd (1.0 kg/sq m).
      a. Net Fabric Width: Approximately 2 inches (50 mm) wide.
      2. Metal: 3 inches (75 mm) wide, 24 gage, 0.0239 inch (0.61 mm) thick galvanized steel.

C. Maximum Installed Length: 14 inch (356 mm).

2.07 MANUAL VOLUME CONTROL DAMPERS


B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Round dampers < 11 inches in short dimension shall be single blade type
D. Rectangular damper > 12 inches in short dimensions shall be multi-bladed opposed blade with maximum 7 1/2 inch individual blades.

E. Damper regulators shall have position indicating dial and locking mechanism

F. Damper actuating system shall have brass bushings (plastic coated fittings not allowed).

G. Splitter Dampers:
   1. Material: Same gage as duct to 24 inches (600 mm) size in either direction, and two gages heavier for sizes over 24 inches (600 mm).
   2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
   3. Operator: Minimum 1/4 inch (6 mm) diameter rod in self aligning, universal joint action, flanged bushing with set screw.

H. Single Blade Dampers: Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
   1. Blade: 24 gage, 0.0239 inch (0.61 mm), minimum.

I. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch (200 by 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
   1. Blade: 18 gage, 0.0478 inch (1.21 mm), minimum.

J. 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.

2.08 REMOTE ACTUATED VOLUME CONTROL DAMPERS

A. Application: Provide battery powered, low-voltage Remote Actuated Volume Control Dampers for any balancing damper located in hard ceiling or inaccessible locations.

B. Manufacturers:
   1. Young's Regulator
   2. Metropolitan Air Technology
   3. Ruskin

C. Description: Balancing Damper actuated by a low votage (9V or 12V) DC motor for use above hard ceilings and in other inaccessible locations. Remote controller provides power, control and damper position feedback via a cable of up to 500 feet.

D. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

E. Shell: Galvanized steel, 24 gage minimum.

F. Blade: Galvanized steel, 20 gage minimum.

G. Shaft: 1/2" Plated Steel

H. Bushing: Oil Impregnated Bronze

I. Controller: Hand held, battery powered controller, with position indicator.

J. Termination: Concealed and located as indicated on Drawings. If termination is not indicated on Drawings, locate termination in concealed,
accessible ceiling areas, or if not feasible, locate termination recessed in hard ceiling with escuteon plate to match ceiling color

2.09 MISCELLANEOUS PRODUCTS

A. Internal Strut End Plugs: Combination end-mounting and sealing plugs for metal conduit used as internal reinforcement struts for metal ducts; plug crimped inside conduit with outside gasketed washer seal.

B. 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

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to 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 for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch (100 by 100 mm) 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 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 2 duct widths from duct take-off.

K. Use splitter dampers only where indicated.
L. 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
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Roof exhausters.
B. Kitchen hood upblast roof exhausters.

1.02  RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.

1.03  REFERENCE STANDARDS

C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
I. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.04  ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of roof openings with size, location and installation of service utilities.
B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05  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 clearly 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.
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 Fan Belts: One set for each individual fan.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the
type of products specified in this section, with minimum three years of
documented experience.

1.07 FIELD CONDITIONS
A. Permanent ventilators may not be used for ventilation during construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS
C. Twin City

2.02 POWER VENTILATORS - GENERAL
A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and
Vibration Levels for Fans.
B. Performance Ratings: Determined in accordance with AMCA 210 and
bearing the AMCA Certified Rating Seal.
C. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA
Certified Sound Rating Seal.
D. Fabrication: Conform to AMCA 99.
E. UL Compliance: UL listed and labeled, designed, manufactured, and tested
in accordance with UL 705.
F. Electrical Components: Listed and classified by Underwriters Laboratories
Inc. as suitable for the purpose specified and indicated.
G. Enclosed Safety Switches: Conform to NEMA 250.
H. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL
762.

2.03 ROOF EXHAUSTERS
A. Performance Ratings: Refer to Drawings.
B. 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.
C. Roof Curb: 12 inch (300 mm) high self-flashing of galvanized steel with continuously welded seams, built-in cant strips. Sound attenuating curb.

D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.

E. 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.

F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

G. Weatherproof hood and bird screen.

2.04 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

A. Performance Ratings: Refer to Drawings

B. Direct Drive Fan:
   1. Fan Wheel:
      a. Type: Non-overloading, backward inclined centrifugal.
      b. Material: Aluminum.
   2. Statically and dynamically balanced.
   3. Motors:
      a. Open drip-proof (ODP).
      b. Heavy duty ball bearing type.
      c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
      d. Fully accessible for maintenance.
   4. Housing:
      a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
      b. Rigid internal support structure.
      c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
      d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
      e. Provide breather tube for fresh air motor cooling and wiring.

C. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.
      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
      c. 100 percent factory tested.

D. Drive Assembly:
   1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
   2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

E. Disconnect Switches:
1. Factory mounted and wired.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Outdoor Locations: Type 3R.
3. Finish for Painted Steel Enclosures: Provide manufacturer’s standard or factory applied gray unless otherwise indicated.
4. Positive electrical shutoff.
5. Wired from fan motor to junction box installed within motor compartment.

F. Roof Curb: 8 inch (200 mm) high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.

G. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

H. Options/Accessories:
1. Automatic Belt Tensioner: Automatic device that adjusts for correct belt tension for single drives.
2. Birdscreen:
   a. Provide galvanized steel construction.
   b. Protects fan discharge.
3. Clean Out Port: Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
4. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
5. Finishes: Factory primed.
6. Grease Trap:
   a. Aluminum.
   b. Includes drain connection.
   c. Collects grease residue.
7. Hinge Kit:
   a. Aluminum hinges.
   b. Hinges and restraint cables mounted to base (sleeve).
   c. Allows fan to tilt away for access to wheel and ductwork for inspection and cleaning.

PART 3 EXECUTION

3.01 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. Provide sheaves required for final air balance.
E. Install backdraft dampers on inlet to roof and wall exhausters.
F. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

3.02 SCHEDULES

A. Refer to Drawings.

END OF SECTION 23 34 23
SECTION 23 36 00

AIR TERMINAL UNITS

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Single-duct terminal units.
   1. Single-duct, constant-volume units.
   2. Single-duct, variable-volume units.

1.02  RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and actuators.
C. Section 23 09 23 - Direct-Digital Control System for HVAC.
D. Section 23 09 93 - Sequence of Operations for HVAC Controls.
E. Section 23 21 13 - Hydronic Piping: Connections to heating coils.
F. Section 23 21 14 - Hydronic Specialties: Connections to heating coils.
G. Section 23 31 00 - HVAC Ducts and Casings.
H. Section 23 33 00 - Air Duct Accessories.

1.03  REFERENCE STANDARDS

B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2011 with Addendum 1.
C. ASHRAE Std 130 - Methods of Testing Air Terminal Units; 2008 (R2014).

1.04  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 air flow, 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. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.

E. Manufacturer’s Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.

F. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

G. 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.

H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.01 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-VOLUME UNITS

A. Manufacturers:
   4. Substitutions:  See Section 01 60 00 - Product Requirements.

B. Basis of Design: Price Industries, Inc.

C. 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.

D. Unit Casing:
   1. Minimum 22 gage, 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. 1/2 inch (13 mm) thick, coated, fibrous-glass complying with ASTM C1071.
         1) Secure with adhesive.
2) Coat edges exposed to airstream with NFPA 90A approved sealant.
3) Cover liner with non-porous foil.

b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

E. Damper Assembly:
1. Heavy-gage, 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.
   a. Air Leakage Past Closed Damper: Maximum two percent of unit maximum airflow at 3 inch wg (750 Pa) inlet static pressure, tested in accordance with ASHRAE Std 130.

F. Hot Water Heating Coil:
1. Coil Casing: Minimum 22 gage, 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.
   b. Right or left coil inlets.
2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
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.

G. Controls:
1. Electronic:
   a. Damper Actuator: 24 volt, power closed, spring return open.
   b. Velocity Controller:
      1) Settings for minimum/maximum air volumes, factory-calibrated, and field adjustable at thermostat.
      2) Maintain constant airflow dictated by thermostat to within 5 percent of set point while compensating for inlet static-pressure variations up to 4 inch wg (1 kPa), when tested in accordance with ASHRAE Std 130.
      3) Provide controller with multi-point with velocity sensors located in air inlets and outlet.
   c. Thermostat: Wall-mounted, time-proportional with reheat-coil control including a temperature set-point display in Celsius and Fahrenheit.
   d. See Section 23 09 13.
   a. Signal accuracy: Plus/minus five percent throughout terminal operating range.
3. Control Sequence:
   a. Suitable for operation with duct pressures between 0.25 and 3.0 inch wg (60 and 750 Pa) inlet static pressure.
   b. Include factory-mounted and piped, 5-micron filter; and adjustable, velocity-resetting, high-limit control with amplifying relay.
   c. See Section 23 09 93.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that conditions are suitable for installation.

3.02 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 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 05 48.
   E. Do not support from ductwork.
   F. Connect to ductwork in accordance with Section 23 31 00.
   G. Provide minimum of 5 ft (1.5 m) of 1 inch (25 mm) thick lined ductwork
      downstream of units.

END OF SECTION 23 36 00
SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Diffusers.
B. Registers/grilles.
C. Roof hoods.

1.02 REFERENCE STANDARDS

C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.03 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.
C. Project Record Documents: Record actual locations of air outlets and inlets.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Refer to Drawings for air outlet and inlet requirements.

2.02 MANUFACTURERS

D. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing with spring or other device to set blades, vertical face, single deflection.
B. Frame: 1 inch (25 mm) margin with countersunk screw mounting and gasket.

C. Fabrication: Steel with 20 gage, 0.0359 inch (0.91 mm) minimum frames and 22 gage, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gage, 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.

E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

### 2.04 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille with one-way deflection.

B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.

C. Fabrication: Aluminum extrusions with factory clear lacquer finish.

D. Color: To be selected by Architect from manufacturer's standard range.

### 2.05 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with spring or other device to set blades, vertical face.

B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.

C. Fabrication: Steel frames and blades, with factory baked enamel finish.

D. Color: To be selected by Architect from manufacturer's standard range.

### 2.06 LINEAR WALL REGISTERS/GRILLES

A. Type: Streamlined blades with 0 degree deflection, 1/8 by 3/4 inch (3.2 by 19 mm) on 1/4 inch (6 mm) centers.

B. Frame: 1 inch (25 mm) margin with concealed mounting and gasket.

C. Fabrication: Aluminum extrusions, with factory baked enamel finish.

D. Color: To be selected by Architect from manufacturer's standard range.

### 2.07 ROOF HOODS

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).

B. Fabricate of galvanized steel, minimum 16 gage, 0.0598 inch (1.52 mm) base and 20 gage, 0.0359 inch (0.91 mm) hood, or aluminum, minimum 16 gage, 0.0598 inch (1.52 mm) base and 18 gage, 0.0598 inch (1.21 mm) hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch (13 mm) square mesh for exhaust and 3/4 inch (19 mm) for intake, and factory prime coat finish.

C. Fabricate louver penthouses with mitered corners and reinforce with structural angles.

D. Mount unit on minimum 12 inch (300 mm) high curb base with insulation between duct and curb.

E. Make hood outlet area minimum of twice throat area.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform 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 the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black.

3.02 AIR OUTLET AND INLET SCHEDULE

A. Refer to Drawings.

END OF SECTION 23 37 00
SECTION 23 81 27

SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Air-source heat pumps.
   B. Air cooled condensing units.
   C. Indoor ductless fan & coil units.
   D. Controls.

1.02 RELATED REQUIREMENTS
   A. Section 22 30 00 - Plumbing Equipment: Cooling condensate removal pumps.

1.03 REFERENCE STANDARDS
   C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.

1.04 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. Project Record Documents: Record actual locations of components and connections.
G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

H. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 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.

2.02 INDOOR UNITS FOR DUCTLESS SYSTEMS

A. 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.

B. 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.

C. Remote Actuators:

2.03 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
   1. Comply with AHRI 210/240.
   2. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
   3. Refrigerant: R-410A.
   4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.

B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).
   1. Provide thermostatic expansion valves.
D. Operating Controls:
   1. Control by room thermostat to maintain room temperature setting.

2.04 ACCESSORY EQUIPMENT

A. Room Thermostat: Wall-mounted, electric solid state microcomputer based
   room thermostat with remote sensor to maintain temperature setting;
   low-voltage; with following features:
   1. Automatic switching from heating to cooling.
   2. Preferential rate control to minimize overshoot and deviation from
      setpoint.
   3. Instant override of setpoint for continuous or timed period from one
      hour to 31 days.
   4. Short cycle protection.
   5. Programming based on weekdays, Saturday and Sunday.
   6. Thermostat Display:
      a. Actual room temperature.
      b. System Mode Indication: Heating, Cooling, Fan Auto, Off, and On,
         Auto or On, Off.

PART 3 EXECUTION

3.01 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.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of
   local authorities having jurisdiction.
B. Install in accordance with NFPA 90A and NFPA 90B.
C. Pipe drain from humidifiers to nearest floor drain.

END OF SECTION 23 81 27
SMALL SPLIT-SYSTEM HEATING AND COOLING
23 81 27 - 4
SECTION 26 05 01

MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

1.02 RELATED REQUIREMENTS

A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

B. Section 02 84 00 - Polychlorinate Biphenyl (PCB) Remediation: Removal of equipment and materials containing substances regulated under the Federal Toxic Substances Control Act (TSCA), including but not limited to those containing PCBs and mercury.

1.03 SUBMITTALS

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

B. Sustainable Design Documentation: Submit certification of removal and appropriate disposal of abandoned cables containing lead stabilizers.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Architect before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with campus facilities office.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 40 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Notify Owner before partially or completely disabling system.
   2. Make notifications at least 40 hours in advance.
   3. Make temporary connections to maintain service in areas adjacent to work area.

F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Notify Owner at least 24 hours before partially or completely disabling system.
   2. Notify telephone utility company at least 24 hours before partially or completely disabling system.

G. Existing ______ System: Maintain existing system in service until new system is complete and ready for service. The new switchgear shall be constructed, tested and energized and all loads switched over prior to demolition of the existing switchboard. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 40 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
   1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
   2. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Repair adjacent construction and finishes damaged during demolition and extension work.

I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

END OF SECTION 26 05 01
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Medium voltage cable.
B. Cable accessories.

1.02 RELATED REQUIREMENTS
A. Section 26 05 53 - Identification for Electrical Systems.

1.03 REFERENCE STANDARDS
A. IEEE 48 - IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV; 1996 (R2009).
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide for cable, terminations, and accessories.
C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.
D. Samples: Submit two samples of each size cable, 24 inches (600 mm) in length.
   1. Select each length to include complete set of manufacturer markings.
E. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.
F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
G. Project Record Documents: Record actual sizes and locations of cables.
H. Maintenance Data: Include instructions for testing and cleaning cable and accessories.
1.05 QUALITY ASSURANCE
A. Comply with 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. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles (160 km) of Project.
D. Products: Listed, classified, and labeled as suitable for the purpose intended.
E. 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

2.01 MEDIUM-VOLTAGE CABLE
A. Manufacturers:
B. Medium Voltage Cable: NEMA WC 74 ethylene propylene insulated cable.
   1. Voltage: 5 kV, grounded.
   2. Conductor: Copper, compact round, stranded, with foil or wire conductor shield.
   4. Insulation Jacket: PVC, 80 mils (2.03 mm) minimum thickness.

2.02 CABLE ACCESSORIES
A. Cable Terminations: IEEE 48, Class 2 porcelain insulator cable terminator in kit form.
B. Cast Epoxy Cable Terminations: IEEE 48, Class 1 cast epoxy cable termination in kit form with stress cone, shield ground connection, wet porcelain rain shield for outdoor units, epoxy resin molding material, and accessories and molds required for proper application.
C. Modular Cable Terminations: IEEE 48, Class 1, molded-rubber cable termination in kit form with stress cone, ground clamp, non-tracking rubber skirts, load break connector, rubber cap, and aerial lug.
D. Fireproofing Tape:

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that conduit, duct, trench, or manholes are ready to receive cable.
B. Verify routing and termination locations of cable bank prior to rough-in.
C. Cable routing is shown in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 PREPARATION
A. Use swab to clean conduits before pulling cables.
3.03 INSTALLATION

A. Avoid abrasion and other damage to cables during installation.
B. Use suitable lubricants and pulling equipment.
C. Sustain cable pulling tensions and bending radii below recommended limits.
D. Ground cable shield at each termination and splice.
E. Install cables in manholes along wall providing longest route.
F. Arrange cable in manholes to avoid interference with duct entrances.
G. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping. Extend fireproofing 1 inch (25 mm) into duct.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect exposed cable sections for physical damage.
C. Inspect cable for proper connections as indicated.
D. Inspect shield grounding, cable supports, and terminations for proper installation.
E. Perform inspections and tests listed in NETA ATS, Section 7.3.3.

3.05 PROTECTION

A. Protect installed cables from entrance of moisture.

END OF SECTION 26 05 13
SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.
B. Metal-clad cable.
C. Manufactured wiring systems.
D. Wiring connectors.
E. Electrical tape.
F. Heat shrink tubing.
G. Oxide inhibiting compound.
H. Wire pulling lubricant.
I. Cable ties.

1.02 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 26 05 01 - Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
C. Section 26 05 13 - Medium-Voltage Cables: Cables and terminations for systems 601 V through 35,000 V.
D. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
F. Section 28 31 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.03 REFERENCE STANDARDS


G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.


K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.


M. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.


P. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.


R. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

S. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.04 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 the contract documents. Obtain direction before proceeding with work.

1.05 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. Sustainable Design Documentation: Submit manufacturer’s product data on conductor and cable showing compliance with specified lead content requirements.

D. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.

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.

1.06 QUALITY ASSURANCE

A. Conform to 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.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer’s instructions.

PART 2 PRODUCTS

2.01 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.

C. Nonmetallic-sheathed cable is not permitted.

D. Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is not permitted.

F. Armored cable is not permitted.

G. 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.
      1) Maximum Length: 6 feet (1.8 m).
      b. Where concealed in hollow stud walls for branch circuits up to 20 A.
      1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
   2. In addition to other applicable restrictions, may not be used:
      a. Unless approved by Owner.
      b. Where not approved for use by the authority having jurisdiction.
c. Where exposed to view.
d. Where exposed to damage.
e. For damp, wet, or corrosive locations, unless provided with a PVC
   jacket listed as suitable for those locations.

H. 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. Unless approved by Owner.
         b. Where not approved for use by the authority having jurisdiction.
         c. Where exposed to damage.
         d. For damp, wet, or corrosive locations.

2.02 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 new conductors and cables manufactured not more than one year
   prior to installation.

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 75 feet (23 m): 10 AWG, for
            voltage drop.
2) 20 A, 120 V circuits longer than 150 feet (46 m): 8 AWG, for voltage drop.
3) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.

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.
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.

2.03 SINGLE CONDUCTOR BUILDING WIRE
A. Description: Single conductor insulated wire.
B. Conductor Stranding:
1. Feeders and Branch Circuits: Stranded.
2. Control Circuits: Stranded.
C. Insulation Voltage Rating: 600 V.
D. 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.

2.04 METAL-CLAD CABLE
A. 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.
B. Conductor Stranding:
1. Size 10 AWG and Smaller: Stranded.
2. Size 8 AWG and Larger: Stranded.
C. Insulation Voltage Rating: 600 V.
D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
E. Provide dedicated neutral conductor for each phase conductor where indicated or required.
F. Grounding: Full-size integral equipment grounding conductor.
G. Armor: Steel, interlocked tape.
H. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.05 MANUFACTURED WIRING SYSTEMS

A. Description: Manufactured wiring assemblies complying with NFPA 70 Article 604, and listed and labeled as complying with UL 183.

B. Provide components necessary to transition between manufactured wiring system and other wiring methods.

C. Branch Circuit Cables:
   2. Insulation Voltage Rating: 600 V.
   3. Insulation: Type THHN.
   5. Armor: Steel, interlocked tape.

D. Connectors: Keyed and color-coded to prevent interconnection of different voltages.

E. Fixture Leads: Type TFN insulation.

2.06 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. 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.

C. 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.

D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

E. 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.

F. Mechanical Connectors: Provide bolted type or set-screw type.
G. Compression Connectors: Provide circumferential type or hex type crimp configuration.

2.07 WIRING ACCESSORIES

A. Electrical Tape:
   1. 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).
   2. 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).
   3. 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.
   4. 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).
   5. 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.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 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 shown on the drawings.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.
3.03 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated and routing is not shown, 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 shown.
   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 shown 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 up to three 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.
      a. Branch circuits fed from ground fault circuit interrupter (GFCI) circuit breakers.
      b. Branch circuits with dimming controls.

B. Install products in accordance with manufacturer’s instructions.

C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.

D. Install metal-clad cable (Type MC) in accordance with NECA 120.

E. 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.

F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

G. 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.

H. Terminate cables using suitable fittings.
   1. 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.

I. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

J. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

K. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

L. 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.

M. 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 taping connections, first apply adequate amount of rubber splicing electrical tape or electrical filler 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.

N. Insulate ends of spare conductors using vinyl insulating electrical tape.

O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

P. 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.

3.04 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.
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

1.01  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 plate electrodes.
G.  Ground access wells.

1.02  RELATED REQUIREMENTS

A.  Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
B.  Section 26 05 36 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.
C.  Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
D.  Section 26 56 00 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03  REFERENCE STANDARDS

B.  NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
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.

1.04  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 the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 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. 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.
D. Field quality control test reports.

1.06 QUALITY ASSURANCE
A. Conform to 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.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store products in accordance with manufacturer’s instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS
A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
C. 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.
D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
E. 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.

F. 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 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.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
7. 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.
8. **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.

**G. 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.

**H. 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.

**I. Separately Derived System Grounding:**
1. Separately derived systems include, but are not limited to:
   a. Transformers (except autotransformers such as buck-boost transformers).
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. 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.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

**J. 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.
K. 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.
L. Cable Tray Systems: Also comply with Section 26 05 36.
M. Pole-Mounted Luminaires: Also comply with Section 26 56 00.

2.02 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).
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 - Exothermic Welded Connections:
      b. Cadweld, a brand of Erico International Corporation:

D. Ground Bars:
   1. **Description:** Copper rectangular ground bars with mounting brackets
      and insulators.
   2. **Size:** 16”x4”x1/4” unless otherwise indicated or required.
   3. **Holes for Connections:** As indicated or as required for connections to
      be made.

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. Where rod lengths of greater than 10 feet (3.0 m) are indicated or
      otherwise required, sectionalized ground rods may be used.

F. Ground Plate Electrodes:
   1. **Material:** Copper.
   2. **Size:** 24 by 24 by 1/4 inches (610 by 610 by 6 mm), unless otherwise
      indicated.

G. 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.
   2. **Size:** As required to provide adequate access for testing and
      inspection, but not less than minimum size requirements specified.
   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".

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify that work likely to damage grounding and bonding system
   components has been completed.

B. Verify that field measurements are as shown on the drawings.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

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

B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.

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. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches (750 mm).

E. 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.

F. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.03 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
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1  GENERAL

1.01  SECTION INCLUDES

A.  Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02  RELATED REQUIREMENTS

A.  Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B.  Section 26 05 34 - Conduit: Additional support and attachment requirements for conduits.
C.  Section 26 05 36 - Cable Trays for Electrical Systems: Additional support and attachment requirements for cable tray.
D.  Section 26 05 37 - Boxes: Additional support and attachment requirements for boxes.
E.  Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

1.03  REFERENCE STANDARDS

D.  MFMA-4 - Metal Framing Standards Publication; 2004.
E.  NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
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.

1.04  ADMINISTRATIVE REQUIREMENTS

A.  Coordination:
   1.  Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2.  Coordinate the work with other trades to provide additional framing and materials required for installation.
   3.  Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4.  Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from the 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 fully cured in accordance with Section 03 30 00.

1.05 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, non-penetrating rooftop supports, and post-installed concrete and 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.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 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 electrical 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 5. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
      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, clamps, etc. suitable for the conduit or cable 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, brackets, etc. suitable for the boxes to be supported.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
   3. 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.
   4. Minimum Channel Thickness: Steel sheet, 12 gage, 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. Manufacturers:

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. Busway Supports: 1/2 inch (13 mm) diameter.
      c. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch (6 mm) diameter.
      d. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch (10 mm) diameter.
      e. Trapeze Support for Multiple Conduits: 3/8 inch (10 mm) diameter.
      f. Outlet Boxes: 1/4 inch (6 mm) diameter.
      g. Luminaires: 1/4 inch (6 mm) diameter.

F. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
   1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
   3. Mounting Height: Provide minimum clearance of 6 inches (150 mm) under supported component to top of roofing.

G. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
5. Steel: Use beam clamps, machine bolts, or welded threaded studs.
8. Plastic and lead anchors are not permitted.
9. Hammer-driven anchors and fasteners are not permitted.
10. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
11. Acoustic Isolation
   a. Isolate electrical equipment including transformers, UPS, inverters, and power conditioners inside the building with captive neoprene mounts equal to Mason Type BR, minimum 0.20-inch deflection and provide flexible connections.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.
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.

3.02 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.
B. Install support and attachment components in a neat and workmanlike manner 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 3 inch (80 mm) high concrete pad constructed in accordance with 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: Also comply with Section 26 05 34.
J. Cable Tray Support and Attachment: Also comply with Section 26 05 36.
K. Box Support and Attachment: Also comply with Section 26 05 37.
L. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.
M. Secure fasteners according to manufacturer’s recommended torque settings.
N. Remove temporary supports.

3.03 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
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Galvanized steel rigid metal conduit (RMC).
B. Intermediate metal conduit (IMC).
C. PVC-coated galvanized steel rigid metal conduit (RMC).
D. Flexible metal conduit (FMC).
E. Liquidtight flexible metal conduit (LFMC).
F. Electrical metallic tubing (EMT).
G. Rigid polyvinyl chloride (PVC) conduit.
H. Conduit fittings.
I. Accessories.

1.02 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 26 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.
D. Section 26 05 29 - Hangers and Supports for Electrical Systems.
E. Section 26 05 37 - Boxes.
F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
G. Section 27 10 05 - Structured Cabling for Voice and Data - Inside-Plant: Additional requirements for communications systems conduits.

1.03 REFERENCE STANDARDS
A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
H. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
J. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
L. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
M. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
N. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
P. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
Q. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
R. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 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. 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.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS
A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
   2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
   3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
   4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit 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 elbows for bends.
   6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
   7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches (100 mm) on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.

D. Embedded Within Concrete:
   1. Within Slab on Grade: Not permitted.
   2. Within Slab Above Ground: Not permitted.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.

4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

K. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

M. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
   1. Maximum Length: 6 feet (1.8 m).

N. Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
   3. Maximum Length: 6 feet (1.8 m) unless otherwise indicated.
   4. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.
      c. HVAC equipment.

2.02 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Communications Systems Conduits: Also comply with Section 27 10 05.

C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.

D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
E. Provide products listed, classified, and labeled as suitable for the purpose intended.

F. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
   2. Control Circuits: 1/2 inch (16 mm) trade size.
   3. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
   5. 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.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
   1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
   1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil (1.02 mm).

C. PVC-Coated Fittings:
   1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
   2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
   4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil (1.02 mm).

D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil (0.38 mm).
2.06 FLEXIBLE METAL CONDUIT (FMC)

A. 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 to be used.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.07 LIQUIDtight FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.08 ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
      a. Do not use indenter type connectors and couplings.
   4. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
   5. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.09 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. 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.

B. 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 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil (0.51 mm).

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force (890 N).

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

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

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install intermediate metal conduit (IMC) in accordance with NECA 101.

E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

G. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

H. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated and routing is not shown, determine exact routing required.
   3. Conceal all 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 conduits exposed:
      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 the shortest possible manner unless otherwise indicated.
      Route all 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 the equivalent of two 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 the same area together on a common rack.

I. Conduit Support:
   1. Secure and support conduits 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. 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 non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
   9. Use of spring steel conduit clips for support of conduits is not permitted.
   10. Use of wire for support of conduits is permitted only as follows:
       a. For securing conduits to studs in hollow stud walls.
   11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

J. 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 a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

K. 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. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. 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. Include proposed locations of penetrations and methods for sealing with submittals.
9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

L. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
   b. Under Slab on Grade: 12 inches (300 mm) to bottom of slab.
2. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.

M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches (76 mm) on all sides unless otherwise indicated.

N. 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 conduits are subject to earth movement by settlement or frost.

O. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or
approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits penetrate coolers or freezers.

P. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches (300 mm) at each end.

Q. Provide grounding and bonding in accordance with Section 26 05 26.

3.03 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.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 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 34
PART 1 GENERAL

1.01 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. Floor boxes.

D. Underground boxes/enclosures.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 34 - Conduit:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

E. Section 26 27 26 - Wiring Devices:
   1. Wall plates.
   2. Floor box service fittings.
   3. Additional requirements for locating boxes for wiring devices.

F. Section 27 10 05 - Structured Cabling for Voice and Data - Inside-Plant: Additional requirements for communications systems outlet boxes.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.


1.04 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 the contract documents. Obtain direction before proceeding with work.

1.05 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. 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.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
PART 2 PRODUCTS

2.01 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 suitable concrete type boxes where flush-mounted in concrete.
5. Use suitable masonry type boxes where flush-mounted in masonry walls.
6. Use raised covers suitable for the type of wall construction and device configuration where required.
7. Use shallow boxes where required by the type of wall construction.
8. Do not use "through-wall" boxes designed for access from both sides of wall.
9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
11. 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. 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.
15. Manufacturers:
C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
   1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA 250 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.
   4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
      a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
   5. Finish for Painted Steel Enclosures: Manufacturer’s standard grey unless otherwise indicated.

D. 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.

E. 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. 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.
   5. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
      a. Combination fiberglass/polymer concrete boxes/enclosures are not acceptable. Use all-polymer concrete boxes/enclosures.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify that field measurements are as shown on drawings.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

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

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 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. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

G. 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 05.
   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 16-inch and one stud bay horizontal separation. If there are locations where the 16-inch separation cannot be maintained, this should be brought to the attention of the architect as soon as possible. In addition, all recessed boxes in acoustic-rated walls are to be fully wrapped with approved putty pads (equal to Lowry's Pads).
   9. Treat boxes in plumbing walls and sound-rated walls with Lowry's pads on all five back sides. Light switches and lw-voltage devices, such as A/V, data and telecom jacks, shall be placed in electrical boxes and treated as such.
  10. 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.
11. 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 34.

12. 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.

H. 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.

I. Install boxes plumb and level.

J. 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.

K. Floor-Mounted Cabinets: Mount on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.

L. Install boxes as required to preserve insulation integrity.

M. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

N. 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.

O. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

P. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
Q. Close unused box openings.
R. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
S. Provide grounding and bonding in accordance with Section 26 05 26.

3.03 CLEANING
A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 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 37
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Wire and cable markers.
D. Voltage markers.
E. Underground warning tape.
F. Warning signs and labels.

1.02 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 27 26 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
F. Section 27 10 05 - Structured Cabling for Voice and Data - Inside-Plant: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 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.

1.05 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.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.07 FIELD CONDITIONS
A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS
A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
B. 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 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 load(s) served for each branch device. Do not identify spares and spaces.
      c. Panelboards:
         1) Identify voltage and phase.
         2) Identify power source and circuit number. Include location when not within sight of equipment.
         3) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
         4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
         5) 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.
e. Enclosed switches, circuit breakers, and motor controllers:
   1) Identify voltage and phase.
2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting
      means.
   b. Use identification label at each piece of service equipment to
      identify the available fault current and the date calculations were
      performed.
3. Use voltage marker to identify highest voltage present for each piece of
   electrical equipment.
4. Use identification nameplate to identify disconnect location for
   equipment with remote disconnecting means.
5. 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.
6. 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.
7. Use identification label to identify overcurrent protective devices for
   branch circuits serving fire alarm circuits. Identify with text "FIRE
   ALARM CIRCUIT".
8. 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.
9. 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.

C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with
   Section 26 05 19.
2. 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.
3. 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. Identification for Raceways:

IDENTIFICATION FOR ELECTRICAL SYSTEMS
26 05 53 - 3
1. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet (6.1 m).
   a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches (76 mm) wide.
      1) Color Code:
         (a) Emergency Power System: Red.
         (b) Fire Alarm System: Red.
      2) Field-Painting: Comply with Section 09 91 23 and 09 91 13.
      3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.

E. Identification for Cable Tray: Comply with Section 26 05 36.

F. 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.
   3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

G. Identification for Devices:
   1. Identification for Communications Devices: Comply with Section 27 10 05.
   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 or engraved wallplate to identify serving branch circuit for all receptacles.
      a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
   5. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

2.02 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.
   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. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. 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. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. Equipment Designation: 1/2 inch (13 mm).
   b. 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:

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.

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.
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 Control Device Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch (5 mm).
5. Color: Black text on clear background.

H. 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.

2.03 WIRE AND CABLE MARKERS
A. 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.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch (3 mm).

F. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

C. 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).

D. Legend:
   1. Markers for Voltage Identification: Highest voltage present.
   2. Markers for System Identification:

E. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. 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.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:
   1. Tape for Buried Power Lines: Black text on red background.

2.06 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
   2. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.

C. 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.
3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 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:
   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.
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. Mark all handwritten text, where permitted, to be neat and legible.

3.03 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 09 14

ELECTRICAL SENSING AND MEASUREMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Instrument transformers.
B. Meters and meter switches and relays.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide electrical ratings, adjustment ranges, enclosure type, outline dimensions, mounting dimensions, and terminal connection information.
C. 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.

1.05 QUALITY ASSURANCE
A. Conform to 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 of Project.
C. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.
D. Meter and accessories shall have a five year warranty

PART 2 PRODUCTS

2.01 MANUFACTURERS
C. eGauge Systems, Submeter EG3 Series: http://www.egauge.net/
2.02 POWER METERS

A. Manufacturers:
   1. Schneider Electric, Power Logic EM4000 Series
   3. eGauge Systems, Submeter EG3010 Series: http://www.egauge.net/

B. Watt-Hour Meters and Wattmeters: ANSI C12.1; three phase induction
type with two stators, each with current and potential coil, rated 5 amperes
and 120 volts at 60 Hertz. Meter suitable for connection to 3 and 4 wire
circuits, up to 8 3-phase 4-wire circuits. Include potential indicating lamps;
adjustments for light and full load, phase balance, and power factor; four
dial clock register; integral demand indicator; ratchets to prevent reverse
rotation; removable meter with draw-out test plug; semi-flush mounted
case with matching cover.

C. Impulse-Totalizing Demand Meter: ANSI C12.1; suitable for use with
switchboard watt-hour meter, including two circuit totalizing relay;
cyclometer; four dial totalizing kilowatt-hour register; positive chart drive
mechanism; capillary pen holding minimum one-month ink supply; and a
roll chart with minimum 31-day capacity. Indicate and record five minute
integrated demand of the totalized system.

D. Sub Meter
   1. Meter shall include network based meter - data logger - web server
      suitable for cumulative KWH and instantaneous KW
   2. Meter shall be capable of recording V, Amps, W, Wh, Hz, VA, VAr, and
      THD
   3. Meter shall be able to operate on 120/240V 1ph/3w, 240V 1ph/2w,
      120/208V 3ph/4w, 277/480V 3ph/4w
   4. Meter shall have 64 Channel logger and 6 year data storage capabilities
      on board
   5. Meter shall meet revenue grade accuracy compliance ANSI C12.1 1%
or C12.20  0.5%
   6. Meter shall meet UL 61010-1 standard -- FCC
   7. Meter shall be installed in suitable enclosure for the installation
      environment
   8. Meter shall communicate via RJ45 port to LAN Network or Internet via
      Cellular connection.
   9. Meter shall provide BACnet communication to EMS system ( BACnet
      TCP/IP)
  10. Meter Shall provide devices software, a browser-based URL display for
customer
  11. Meter device software shall provide graphical display of energy
  12. Meter device software shall provide monthly summary of energy in
      chart form
  13. Meter shall provide DHCP or static IP address
  14. Meter device software shall provide instantaneous on all input Current
      and Voltage terminal as well as calculated PF and KW values for each
      register
  15. Meter shall provide XML API data output for customer or 3rd SAAS
      provider
  16. Meter CT sensors shall meet IEEE C57.13 option C0.6 or suitable
      alternative.
17. Meter CT sensors provided by manufacturer for install application. Contractor may not provide alternative CT sensors instead of sensors provided by manufacturer.
18. Meter CT sensor shall have 0.333v output signal.

### 2.03 METERING TRANSFORMERS

A. Current Transformers: IEEE C57.13; 5 ampere secondary, wound type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: IEEE C57.13; 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Meter shall be installed according to all electrical code requirements.
C. Installing contractor may supply suitable enclosure or enclosure may be provided by manufacturer.
D. Meter requires Voltage reference for each Voltage phase being measured.
E. Installing contractor shall provide suitable Voltage reference (breaker, or tap).
F. Installing contractor shall provide LAN or cellular internet connection.
G. See owner manual for full installation documentation.
H. Installing contractor shall configure meter device to match installation.
I. Installing contractor shall provide field verification of initial reading.
J. Installing contractor shall provide customer with verification of accurate installation, meter device ID, device URL, serial #, and MAC address.
K. See manufacturer's configuration guide” for full configuration document.
L. 

END OF SECTION 26 09 14
SECTION 26 09 19

ENCLOSED CONTACTORS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. General purpose contactors.
B. Lighting contactors.

1.02 RELATED REQUIREMENTS
A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
B. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS
D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide dimensions, size, voltage ratings and current ratings.
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.

1.05 QUALITY ASSURANCE
A. Conform to 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

2.01 MANUFACTURERS
B. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 GENERAL PURPOSE CONTACTORS
A. Description: NEMA ICS 2, AC general purpose magnetic contactor.
B. Coil operating voltage: 120 volts, 60 Hertz.
C. Poles: As required to match circuit configuration and control function.
D. Enclosure: NEMA ICS 6, Type 1.
E. Accessories:
   1. Pushbutton: ON/OFF.
   2. Selector Switch: ON/OFF.

2.03 LIGHTING CONTACTORS
A. Description: NEMA ICS 2, magnetic lighting contactor.
B. Configuration: Electrically held.
C. Coil operating voltage: 120 volts, 60 Hertz.
D. Poles: As required to match circuit configuration and control function.

2.04 ACCESSORIES
A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.
B. Cover Mounted Pilot Devices: NEMA ICS 5, standard type.
C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.

2.05 DISCONNECTS
A. Combination Contactors: Combine contactor with disconnect in common enclosure.
B. Disconnects: Thermal magnetic circuit breaker with integral thermal and instantaneous magnetic trip in each pole; UL listed.
C. Disconnects: Fusible switch assembly; NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install enclosed contactors where indicated, in accordance with manufacturer's instructions.
B. Install enclosed contactors plumb. Provide supports in accordance with Section 26 05 29.
C. Provide fuses for fusible switches; refer to Section 26 28 13 for product requirements.

3.02 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 applicable inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION 26 09 19
ENCLOSED CONTACTORS
26 09 19 - 4
SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Occupancy sensors.
B. Outdoor motion sensors.
C. In-wall time switches.
D. In-wall interval timers.
E. Outdoor photo controls.
F. Daylighting controls.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 37 - Boxes.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
D. Section 260924 - Network Lighting Controls: Digital lighting controls for interior and exterior lighting.
E. 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.
F. Section 26 51 00 - Interior Lighting.
G. Section 26 56 00 - Exterior Lighting.

1.03 REFERENCE STANDARDS

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
E. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.

J. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.


1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
   3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
   4. Coordinate the 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 installed under other sections or by others.
   5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1.05 SUBMITTALS

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

B. Product Data: Include ratings, 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. 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. 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.

I. Project Record Documents: Record actual installed locations and settings for lighting control devices.

### 1.06 QUALITY ASSURANCE

A. Conform to 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.

### 1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

### 1.08 FIELD CONDITIONS

### 1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all occupancy sensors.

C. Provide two year manufacturer warranty for all daylighting controls.

### PART 2 PRODUCTS

#### 2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

#### 2.02 OCCUPANCY SENSORS

A. Manufacturers:
   3. Substitutions: See Section 01 60 00 - Product Requirements.
   4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. All Occupancy Sensors:
   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 (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
b. Passive Infrared/Acoustic Dual Technology Occupancy Sensors:
   Designed to detect occupancy using a 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 an 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.


9. Adaptive Technology: Field selectable; capable of self-adjusting
   sensitivity and time delay according to conditions.

10. 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.

11. Load Rating for Line Voltage Occupancy Sensors: As required to
    control the load indicated on the drawings.

12. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts,
    ratings as required for interface with system indicated.

13. Where wired sensors are indicated, wireless sensors are acceptable
    provided that all components and wiring modifications necessary for
    proper operation are included.

14. Wireless Sensors:
   a. RF Range: 30 feet (9 m) through typical construction materials.
   b. Electromagnetic Interference/Radio Frequency Interference
      (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15,
      for Class B application.
   c. Power: Battery-operated with minimum ten-year battery life.

C. Wall Switch Occupancy Sensors:
1. All Wall Switch Occupancy Sensors:
   a. Description: Occupancy sensors designed for installation in
      standard wall box at standard wall switch mounting height with a
      field of view of 180 degrees, integrated manual control capability,
      and no leakage current to load in off mode.
   b. Where indicated, provide two-circuit units for control of two
      separate lighting loads, with separate manual controls and
      separately programmable operation for each load.
   c. Operation: Field selectable to operate either as occupancy sensor
      (automatic on/off) or as vacancy sensor (manual-on/automatic off).
   d. 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 the delayed-off time interval.

2. Passive Infrared/Acoustic Dual Technology Wall Switch Occupancy
   Sensors: Capable of detecting motion within an 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 a 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 the 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. Finish: Match finishes specified for wiring devices in Section 26 27, unless otherwise indicated.

E. Ceiling Mounted Occupancy Sensors:
1. All Ceiling Mounted Occupancy Sensors:
   a. Description: Low profile occupancy sensors designed for ceiling installation.
   b. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
   c. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
   d. Finish: White unless otherwise indicated.
2. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet (41.8 sq m) at a mounting height of 9 feet (2.7 m), with a 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 an area of 450 square feet (41.8 sq m) at a mounting height of 9 feet (2.7 m), with a field of view of 360 degrees.
   b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet (111.5 sq m) at a mounting height of 9 feet (2.7 m).

F. Directional Occupancy Sensors:
1. All Directional Occupancy Sensors: Designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
   a. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
2. Passive Infrared (PIR) Directional Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within a distance of 40 feet (12 m) at a mounting height of 10 feet (3.1 m).
b. Long Range Sensors: Capable of detecting motion within a distance of 80 feet (24 m) at a 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 all associated wiring and accessories as required to control the load indicated on the drawings.
   3. Input Supply Voltage: Dual rated for 120/277 V ac.
   4. Load Rating: As required to control the load indicated on the 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:
      a. General Purpose Load: Not less than 16 A.
      b. Motor Load: Not less than 1/2 HP (120V) and 1.5 HP (277V).

2.03 OUTDOOR MOTION SENSORS

A. 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.

B. Sensor Technology: Passive Infrared (PIR) designed to detect occupancy by sensing movement of thermal energy between zones.

C. 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 an adjustable turn-off delay time interval.

D. Turn-Off Delay: Field adjustable, with time delay settings available up to 15 minutes.

E. Integral Photocell: For dusk to dawn operation.

F. Manual Override: Activated by switching power off to unit and then back on.

G. Load Rating: 1,000 W incandescent and fluorescent load at 120 V ac.

H. Coverage: Capable of detecting motion within a distance of 50 feet (15 m) at a mounting height of 8 feet (2.4 m), with a field of view of 270 degrees.

2.04 IN-WALL TIME SWITCHES

A. 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. 7-Day Time Switches: Capable of different schedule for each day of the week.
      b. Astronomic Time Switches: Capable of different schedule for each day of the 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 power outage backup to retain programming and maintain clock.
5. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
6. Switch Configuration: Suitable for use in either SPST or 3-way application.

2.05 IN-WALL INTERVAL TIMERS

A. 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.

2.06 OUTDOOR PHOTO CONTROLS

A. 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.
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 the load indicated on the drawings.
7. Failure Mode: Fails to the on position.
8. Load Rating: As required to control the load indicated on the drawings.

B. Locking Receptacle-Mounted Outdoor Photo Controls
1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on a compatible receptacle, listed and labeled as complying with UL 773.
2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
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 the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.

C. 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.
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 the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.

2.07 DAYLIGHTING CONTROLS

A. Manufacturers:

B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.

C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the 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.

D. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts, for direct continuous dimming of up to 50 drivers.

E. Daylighting Control Switching Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors, for switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
1. Operation: 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 a no switching dead band between set points to prevent unwanted cycling.
2. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
3. Control Capability:

F. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts, for both continuous dimming of compatible dimming ballasts and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
1. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
2. Control Capability: Capable of controlling up to three separately programmable channels, with up to 50 ballasts per channel.
3. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
4. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.

G. Power Packs for Low Voltage Daylighting Control Modules:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.
2. Input Supply Voltage: Dual rated for 120/277 V ac.

H. Accessories:
1. Where indicated, provide compatible accessory wall switches for manual override control.

PART 3 EXECUTION

3.01 EXAMINATION

A. 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.
B. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
C. Verify that final surface finishes are complete, including painting.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
E. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 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.

3.03 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 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 37 as required for installation of lighting control devices provided under this section.
1. Mounting Heights: Unless otherwise indicated, as follows:
   a. Wall Switch Occupancy Sensors: 48 inches (1.2 m) above finished floor.
   b. In-Wall Time Switches: 48 inches (1.2 m) above finished floor.
   c. In-Wall Interval Timers: 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. Install lighting control devices in accordance with manufacturer's instructions.

D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

E. Install lighting control devices plumb and level, and held securely in place.

F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.

G. 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.

H. Occupancy Sensor Locations:
   1. Location Adjustments: Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage.
   2. Locate dual technology occupancy sensors a 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.

I. 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 the photo control itself.

J. 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 the photo control.

K. Daylighting Control Photo Sensor Locations:
   1. Location Adjustments: Within the 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 the light level controlled at the designated task location, while minimizing the 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 the space, while minimizing the measured amount of lighting from artificial sources.

L. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.
M. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

3.04 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 lighting control devices.

3.05 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.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.
3.07 COMMISSIONING
   A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

3.08 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, 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 the installed lighting control devices.
      4. Location: At project site.

END OF SECTION 26 09 23
PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Network lighting control system and components:
   1. Touch panel controls
   2. Lighting management panels
   3. Lighting management modules
   4. Low voltage wall stations
   5. Power interfaces
   6. Wired sensors

1.02 RELATED DOCUMENTS

A. Section 262726 Wiring Devices
B. Section 260923 Lighting Control Devices
C. Section 265100 Interior Lighting Fixtures
D. Section 265600 Exterior Lighting

1.03 SUMMARY

A. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.

B. The system shall interface with the Energy Monitoring System via BacNet communications and shall provide full reporting of systems function and status of devices. Occupancy sensors shall be able to communicate room status for on/off enabling of HVAC system serving the space monitored.

C. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Specific dimmers will be capable of “dimming lights to off”

D. All system devices shall be networked together, enabling digital communication between devices, and shall be individually addressed.

E. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity, even if network connectivity to the greater system is lost.

F. The system architecture shall facilitate remote operation via a computer connection.

G. The system shall not require any centrally hardwired switching equipment.

1.04 SUBMITTALS

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

B. Design Documents: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", Lighting
Control Manufacturer to provide plans indicating occupancy/vacancy and/or daylight sensor locations.

C. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
   1. Occupancy/Vacancy Sensors: Include detailed basic motion detection coverage range diagrams.

D. Shop Drawings:
   1. Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.
   2. Provide detailed sequence of operations describing system functions.

E. Samples:
   1. Wall Controls:
      a. Show available color and finish selections.
      b. Provide one sample(s) for each product proposed for substitution upon request.
   2. Sensors: Provide one sample(s) for each product proposed for substitution upon request.

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. System Performance-Verification Documentation: Include as part of the base bid additional costs for manufacturer's enhanced documentation detailing start-up performance-verification procedures and functional tests performed along with test results.

H. Title 24 Acceptance Testing Documentation: Submit Certification of Acceptance and associated documentation for lighting control acceptance testing performed in accordance with CAL TITLE 24 P6, as specified in Part 3 under "COMMISSIONING".

I. Project Record Documents: Record actual installed locations and settings for lighting control system components.

J. Operation and Maintenance Data: Include detailed information on lighting control system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

K. Warranty: Submit sample of manufacturer's Warranty or Enhanced Warranty as specified in Part 1 under "WARRANTY". Submit documentation of final execution completed in Owner's name and registered with manufacturer.

L. Software: One copy of software provided under this section.

**1.05 ADMINISTRATIVE REQUIREMENTS**

A. Coordination:
   1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall controls with actual installed door swings.
   3. Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement
with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
4. Where motorized window treatments are to be controlled by the lighting control system provided under this section, coordinate the work with other trades to provide compatible products.
5. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
1. Low voltage wiring requirements.
2. Separation of power and low voltage/data wiring.
3. Wire labeling.
4. Lighting management hub locations and installation.
5. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", sensor locations to be reviewed in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
6. Control locations.
7. Computer jack locations.
8. Load circuit wiring.
9. Network wiring requirements.
10. Connections to other equipment and other Lutron equipment.
11. Installer responsibilities.
12. Power panel locations.

C. Sequencing:
1. Do not install sensors and wall controls until final surface finishes and painting are complete.

1.06 PROJECT CLOSEOUT DOCUMENTATION
A. Provide a factory published manual
1. Warranty
2. Technical support contact
3. Electronic manual on manufacturer’s website for free download

1.07 QUALITY ASSURANCE
A. All steps in sensor manufacturing process shall occur in North America; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.
B. All components and the manufacturing facility where product was manufactured must be RoHS compliant.
C. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.
D. All applicable products must be UL / CUL Listed or other acceptable national testing organization.
E. Conform to requirements of NFPA 70.
F. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

G. Manufacturer Qualifications:
1. Company with not less than ten years of experience manufacturing lighting control systems of similar complexity to specified system.
2. Registered to ISO 9001, including in-house engineering for product design activities.
3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.

H. Title 24 Acceptance Testing Technician Qualifications: Certified by a California approved Acceptance Test Technician Certification Provider (ATTCP) as an Acceptance Test Technicians (ATTs) in accordance with CAL TITLE 24 P6.

I. Maintenance Contractor Qualifications: Manufacturer’s authorized service representative.

1.08 PROJECT CONDITIONS
A. Only install equipment after the following site conditions are maintained:
   1. Ambient Temperature 14 to 105 degrees F (-10 to 40 degrees C)
   2. Relative Humidity less than 90% non-condensing
B. Standard electrical enclosures are permanently installed
C. Equipment is protected from dust, debris and moisture
   1. Warranty
D. Five (5) year 100% parts replacement

1.09 MAINTENANCE & SUSTAINABILITY
A. Provide new parts, upgrades, and/or replacements available for a minimum of 5 years available to the end user
B. Provide free telephone technical support

PART 2 – PRODUCTS
2.01 MANUFACTURERS
   1. Other Acceptable Manufacturers:
      a. Encelium.
      b. WattStopper.
      c. Products by listed manufacturers are subject to compliance with specified requirements and prior approval of Architect.
2. Substitutions: See Section 01 60 00 - Product Requirements.
   a. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by Architect a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
   b. Any proposed substitutions to be reviewed by Architect at Contractor’s expense at a rate of $200 per hour.
   c. By using pre-approved substitutions, Contractor accepts responsibility and associated costs for all required modifications to related equipment and wiring. Provide complete engineered shop
drawings (including power wiring) with deviations from the original design highlighted in an alternate color for review and approval by Architect prior to rough-in.

3. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS

A. Sensor Layout and Tuning: Include as part of the base bid additional costs for Lighting Control Manufacturer's Sensor Layout and Tuning service; By system manufacture:

1. Lighting Control Manufacturer to take full responsibility for wired or wireless sensor layout and performance for sensors provided by Lighting Control Manufacturer.

2. Lighting Control Manufacturer to analyze the reflected ceiling plans, via supplied electronic AutoCAD format, and design a detailed sensor layout that provides adequate occupancy sensor coverage and ensures occupancy and daylight sensor performance per agreed upon sequence of operations. Contractor to utilize the layouts for sensor placement.

3. During startup, Lighting Control Manufacturer to direct Contractor regarding sensor relocation, as required, should conditions require a deviation from locations specified in the drawings.

4. Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits, within one calendar year from Date of Substantial Completion to fine-tune sensor calibration per the agreed upon sequence of operations.

2.03 SYSTEM REQUIREMENTS

A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.

B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

C. System may interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see Networked LED Luminaire section).

D. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.

E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

F. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.

G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.

**2.04 INDIVIDUAL DEVICE SPECIFICATIONS**

**A. Control module (gateway)**

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet network.
2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
3. Control device shall have three RJ-45 ports for connection to the graphic touch screen, other backbone devices (bridges) or directly to lighting control devices (up to 128 per port).
4. Device shall automatically detect all devices downstream of it.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
7. Device shall have a USB port.
8. Each control gateway device shall be capable of linking 1500 devices to the management software, with reduced memory version capable of support up to 400 devices.
9. Device shall be capable of using a dedicated static or DHCP assigned IP address.

**B. Networked system occupancy sensors**

1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants.
5. Sensors shall be available in multiple lens options which are customized for specific applications.
6. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

7. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.

8. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue.

9. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.

10. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.

11. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.

12. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

C. Wall switch sensors shall be available with raise/lower dimming adjustment controls.

D. Networked system daylight (photocell and/or dimming) sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

2. Photocell and dimming sensor’s set-point and deadband shall be 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.

3. Deadband setting shall be 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).

4. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the “auto set-point” setting.)

5. Combination units that have all features of on/off photocell and dimming sensors shall also be available.

6. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an “offset” from the primary zone.

E. Networked System Power (Relay) Packs

1. Power Packs shall incorporate one Class 1 relay, a 0-10 VDC dimming output, and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
3. All devices shall have two RJ-45 ports.
4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
7. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
8. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
9. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
10. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
11. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
12. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
13. Power (Secondary) Packs shall be available that provide up to 20 Amps switching of general purposed receptacle (plug-load) control.

F. Networked System Relay & Dimming Panels
1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.
5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.

G. Networked System Wall Switches & Dimmers
1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
3. All devices shall have two RJ-45 ports.
4. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
5. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
6. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
7. Devices with mechanical push-buttons shall be made available with custom button labeling.
8. Devices with a single "on" button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

H. Networked System Graphic Wall Station
1. Device shall have a 3.5” full color touch screen for selecting up to 16 programmable lighting control preset scenes or acting as up to 16 on/off/dim control switches.
   a. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
      1) Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
         a) Device shall enable user supplied .jpg screen saver image to be uploaded.
         b) Device shall surface mount to single-gang switch box.
         c) Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
         d) Device shall have a micro-USB style connector for local computer connectivity.
         e) Device shall have two RJ-45 ports for communication.

I. Networked System Scene Controllers
1. Device shall have two, three, four, or eight buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
3. Device shall recess into single-gang switch box and fit a standard GFI opening.
4. Devices shall provide LED user feedback.
5. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
6. All devices shall have two RJ-45 ports.
7. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
8. Device shall be capable of selecting a lighting profile be run by the system’s upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
9. Device shall have LEDs indicating current selection.

J. Communication Bridges
1. Device shall surface mount to a standard 4” x 4” square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.

5. Device shall be capable of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.05 CONTROL STATIONS

A. Provide control stations with configuration as indicated or as required to control the loads as indicated.

B. Wired Control Stations:
   1. General Requirements:
      a. Power: Class 2 (low voltage).
      b. UL listed.
      c. Provide faceplates with concealed mounting hardware.
      d. Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
      e. Finish: As specified for wall controls in "Device Finishes" under DIGITAL NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS article above.

2. Multi-Scene Wired Control:
   a. General Requirements:
      1) Allows control of any devices part of the lighting control system.
      2) Allows for easy reprogramming without replacing unit.
      3) Replacement of units does not require reprogramming.
      4) Communications: Utilize RS485 wiring for low-voltage communications link.
      5) Engrave keypads with button, zone, and scene descriptions to be selected by Architect.
      6) Software Configuration:
         (a) Customizable control station device button functionality:
            (1) Buttons can be programmed to perform single defined action.
            (2) Buttons can be programmed to perform defined action on press and defined action on release.
            (3) Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.
            (4) Buttons can be programmed to perform automatic sequence of defined actions.
            (5) Capable of deactivating select keypads to prevent accidental changes to light levels.
            (6) Buttons can be programmed for raise/lower of defined loads.
            (7) Buttons can be programmed to toggle defined set of loads on/off.
         7) Status LEDs:
            (a) Upon button press, LEDs to immediately illuminate.
            (b) LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
(c) Support logic that defines when LED is illuminated:
   (1) Scene logic (logic is true when all zones are at defined levels).
   (2) Room logic (logic is true when at least one zone is on).
   (3) Pathway logic (logic is true when at least one zone is on).
   (4) Last scene (logic is true when spaces are in defined scenes).

b. Wired Keypads:
   1) Style: Architectural Insert Style.
   2) Mounting: Wallbox or low-voltage mounting bracket; provide wall plates with concealed mounting hardware.
   3) Button/Engraving Backlighting:
      (a) Utilize backlighting for buttons and associated engraving to provide readability under all light conditions.
      (b) Backlight intensity adjustable via programming software.
   4) Design keypads to allow field-customization of button color, configuration, and engraving using field-changeable replacement kits.
   5) Contact Closure Interface: Provide two contact closure inputs on back of unit which provide independent functions from front buttons; accepts both momentary and maintained contact closures.
   6) Terminal block inputs to be over-voltage and miswire-protected against reversals and shorts.

3. Single-Scene or Zoned Wired Control:
   a. Turn an individual fixture or group of fixtures on and off.
   b. Raise and lower light levels.
   c. Recall favorite light levels.

4. Four-Button Preset Wallstation:
   a. Recall four scenes plus all on or all off for one group of fixtures.
   b. Master raise/lower control for entire group of fixtures.
   c. Integral IR receiver for personal control.
   d. Immediate local LED response upon button activation to indicate that a system command has been requested.

2.06 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Specific device parameters (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device, with a system backup on the software’s host server.
F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.07 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software.

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.

I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network).

2.08 BMS COMPATIBILITY

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software.

B. BACnet IP connection shall also be available utilizing JACE-600 hardware unit.

C. BACnet IP hardware shall be capable of supporting up to 1500 total devices across up to 5 total Gateways

D. BACnet IP connection shall communicate information gathered by networked system to other building management systems.
E. BACnet IP connection shall translate and forward lighting relay and other select control commands from BMS system to networked control devices via profiles stored in the system Gateway. All system devices shall be available for polling for devices status.

2.09 ACCESSORIES

A. Emergency Lighting Interface:
   1. Provides total system listing to UL 924 when used with lighting control system.
   2. Senses all three phases of building power.
   3. Provides an output to power panels or digital ballast interfaces if power on any phase fails and sends all lights controlled by these devices to an emergency light level setting. Lights to return to their previous intensities when normal power is restored.
   4. Accepts a contact closure input from a fire alarm control panel.

B. Provide power supplies as indicated or as required to power system devices and accessories.
   1. Product(s):
      a. Junction box-mounted power supply for shades, keypads, and accessories, and for providing additional low voltage power to communication link; with miswire and thermal protection.
      b. Plug-in power supply for shades, drapery drive units, keypads, and accessories, and for providing additional low voltage power to communication link; with miswire protection; powered from standard receptacle using cord 6 feet (1.8 m) in length.

C. Provide locking covers for controls where indicated.
   1. Reversible to allow lock to be located on either side of control.
   2. Compatible with IR controls.
   3. Does not reduce specified IR range by more than 50 percent of its original specification.

2.10 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory Testing:
   1. Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.
   2. Perform full-function factory testing on 100 percent of all ballasts and LED drivers.
   3. Perform factory audit burn-in of all dimming assemblies and panels at 104 degrees F (40 degrees C) at full load for two hours.
   4. Provide factory testing reports including all setpoints to commissioning agent as prerequisite to functional testing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that ratings and configurations of system components are consistent with the indicated requirements.

B. Verify that mounting surfaces are ready to receive system components.

C. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.

B. Install products in accordance with manufacturer's instructions.

C. Define each dimmer/relay load type, assign each load to a zone, and set control functions.

D. Sensor Locations:
   1. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", locate sensors in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated. Where Lighting Control Manufacturer Sensor Layout and Tuning service is not specified, locate sensors in accordance with Drawings.
   2. Sensor locations indicated are diagrammatic. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage, in accordance with manufacturer's recommendations.

E. Mount exterior daylight sensors to point due north with constant view of daylight.

F. Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted and luminaire-mounted daylight sensors to avoid direct view of luminaires.

G. Automated Shade Control Sensors:
   1. Mount rooftop cloudy day sensors to point in the direction of each facade.
   2. Ensure that window shadow sensor placement provides an unobstructed view of outdoors. Do not place at a skylight or above indirect luminaires.

H. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

I. LED Light Engine/Array Lead Length: Do not exceed 100 feet (31 m).

J. Identify system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Manufacturer's Startup Services:
   1. Manufacturer's authorized Service Representative to conduct minimum of two site visits to ensure proper system installation and operation.
   2. Conduct Pre-Installation visit to review requirements with installer as specified in Part 1 under "Administrative Requirements".
   3. Conduct second site visit upon completion of lighting control system to perform system startup and verify proper operation:
      a. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", authorized
Service Representative to verify sensor locations, in accordance with layout provided by Lighting Control Manufacturer; Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.

b. Verify connection of power wiring and load circuits.
c. Verify connection and location of controls.
d. Energize lighting management hubs and download system data program.
e. Address devices.
f. Verify proper connection of panel links (low voltage/data) and address panel.
g. Verify system operation control by control.
h. Verify proper operation of manufacturer's interfacing equipment.
i. Configure initial groupings of ballast for wall controls, daylight sensors and occupancy sensors.
j. Provide initial rough calibration of sensors; fine-tuning of sensors is responsibility of Contractor unless provided by Lighting Control Manufacturer as part of Sensor Layout and Tuning service where specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS".
k. Train Owner's representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".
l. Obtain sign-off on system functions.

4. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

### 3.04 ADJUSTING

A. On-Site Scene and Level Tuning: Include as part of the base bid additional costs for Lighting Control Manufacturer to visit site to conduct meeting with Engineer to make required lighting adjustments to the system for conformance with original design intent.

B. Sensor Fine-Tuning: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits for fine-tuning of sensor calibration. Where Lighting Control Manufacturer Sensor Layout and Tuning service is not specified, Contractor to provide fine-tuning of sensor calibration.

### 3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

### 3.06 COMMISSIONING

A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

B. Title 24 Acceptance Testing Service: Include as part of the base bid additional costs for Lighting Control Manufacturer to perform lighting control acceptance testing in accordance with CAL TITLE 24 P6. Submit required documentation.

### 3.07 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:
   1. On-Site Performance-Verification Walkthrough: Include as part of the base bid additional costs for lighting control manufacturer to provide on-site demonstration of system functionality to commissioning agent.

D. Training:
   1. Include services of manufacturer's authorized Service Representative to perform on-site training of Owner's personnel on operation, adjustment, and maintenance of lighting control system as part of standard system start-up services.
      a. Include training on software to be provided:
         1) Configuration software used to make system programming and configuration changes.
         2) Control and monitor.
         3) Energy savings display software.
   2. Customer-Site Solution Training Visit: Include as part of the base bid additional costs for Lighting Control Manufacturer to provide one day(s) of additional on-site system training.

3.08 PROTECTION
A. Protect installed products from subsequent construction operations.

3.09 MAINTENANCE
A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. System Optimization Visit: Include as part of the base bid additional costs for Lighting Control System Manufacturer to visit site six months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

3.10 START-UP & SUPPORT FEATURES
A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.
   1. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
   2. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
   3. All system devices shall be capable of being given user defined names.
   4. All devices within the network shall be able to have their firmware upgraded remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
   5. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

END OF SECTION 26 09 24
SECTION 26 12 00

MEDIUM-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Liquid-filled pad-mounted distribution transformers.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Pads for transformer support.

1.03 REFERENCE STANDARDS

C. IEEE C57.12.01 - IEEE Standard for General Requirements for Dry-Type Distribution and Power Transformers; 2015.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate electrical characteristics and connection requirements, outline dimensions, connection and support points, weight, specified ratings and materials.
C. Product Data: Provide electrical characteristics and connection requirements, standard model design tests, and options.
D. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.
E. Manufacturer's Installation Instructions.
F. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

G. Manufacturer’s Field Reports: Indicate activities on site, final adjustments and overcurrent protective device coordination curves, adverse findings, and recommendations.

H. Maintenance Data: Include maintenance instructions for cleaning methods; cleaning materials recommended; procedures for sampling and maintaining fluid.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Fuses: One of each type and size.
   2. Tools: One each of every special tool required to operate and maintain transformer.

1.05 QUALITY ASSURANCE

A. Conform to 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. Testing Agency Qualifications: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.01 MANUFACTURERS


C. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 LIQUID-FILLED TRANSFORMERS

A. Liquid-Filled Transformers: IEEE C57.12.00, three phase, pad-mounted, self-cooled transformer unit.

B. Cooling and Temperature Rise; IEEE C57.12.00; Class OA. 55 degrees C, self-cooled.

C. Insulating Liquid: Oil.

2.03 SERVICE CONDITIONS

A. Meet requirements for usual service conditions described in IEEE C57.12.01 and for the specified unusual service conditions.

B. Maximum Ambient Temperature: 104 degrees F (40 degrees C).

2.04 ACCESSORIES

A. Accessories: IEEE C57.12.00 standard accessories.

B. Tap Changer: Externally-operated type.
C. Primary Terminations: Bushing wells to IEEE 386; provide three for radial feed. Include bushings for insulated loadbreak connectors.
D. Primary Switching: Fused air switch, gang operated.
E. Primary Overcurrent Protection: Internally-mounted, liquid-immersed, expulsion fuses.
F. Secondary Terminations: Spade lugs.

2.05 FABRICATION
A. Conform to the requirements of IEEE C57.12.28.

2.06 FACTORY FINISHING
A. Clean surfaces before applying paint.
B. Apply corrosion-resisting primer to all surfaces.
C. Apply finish coat of baked enamel paint to 2 mils (0.5 mm) thick.
D. Finish Color: Manufacturer's standard dark gray finish.

2.07 SOURCE QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Provide factory tests to IEEE C57.12.90 and IEEE C57.12.00. Include the routine tests as defined in the standards and the following other tests:
   1. Impedance voltage and load loss.
   2. Audible sound level.
C. Test insulating liquid samples in accordance with IEEE C57.111.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that support pads provided under Section 03 30 00 are ready to receive products.

3.02 INSTALLATION
A. Install plumb and level.
B. Install safety labels to NEMA 260.

3.03 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 7.2. In addition to the basic requirements of Section 7.2, include the following:
   1. Liquid-Filled Transformers:
      a. If core ground strap is accessible, remove and measure core insulation resistance at 500 volts dc.
3.04 ADJUSTING

A. Adjust primary taps so that secondary voltage is above and within 2 percent of rated voltage.

END OF SECTION 26 12 00
SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. General purpose transformers.
B. K-factor transformers rated for nonlinear loads.

1.02 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 34 - Conduit: Flexible conduit connections.

1.03 REFERENCE STANDARDS
B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; 1982 (R2006).
C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2009.
F. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.05 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.
   1. Vibration Isolators: Include attachment method and rated load and deflection.

C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.

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, and installation of product.

1.06 QUALITY ASSURANCE

A. Conform to 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.

1.07 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.

PART 2 PRODUCTS

2.01 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.

2.02 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. 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.

C. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

D. 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.

E. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

F. Sound Levels: Standard sound levels complying with NEMA ST 20.

G. 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.

   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 2.
   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.

I. Accessories:
   1. Mounting Brackets: Provide manufacturer's standard brackets.
2.03 K-FACTOR TRANSFORMERS RATED FOR NONLINEAR LOADS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 1561, and designed to supply nonlinear loads to the degree designated by the UL defined K-factor; ratings as indicated on the drawings.

B. K-factor Rating: K-4, or higher.

C. Insulation System and Allowable Average Winding Temperature Rise: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

D. Coil Conductors: Continuous aluminum windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.

E. Winding Taps: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.

F. Neutral Bus: Sized to accommodate twice the rated secondary current.

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. Up to 75 kVA: Suitable for wall, floor, or trapeze mounting.
   2. Larger than 75 kVA: Suitable for floor mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      2. Construction: Steel, ventilated.
      3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
      4. Provide lifting eyes or brackets.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

B. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install transformers 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 34, 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. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

G. Mount floor-mounted transformers on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.

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 shown on the drawings.

K. All transformers inside the building are to have external captive neoprene vibration isolation mounts equal to Mason BR. Selection to have a minimum 0.20-inch static deflection.

3.03 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 Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

3.04 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.

3.05 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
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.02 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 27 13 - Electricity Metering: For interface with equipment specified in this section.

F. Section 26 43 00 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.


C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.


E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

F. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.

G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.


I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.


L. UL 891 - Switchboards; Current Edition, Including All Revisions.
M. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.04 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. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 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 switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, 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 switchboards 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.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 2 as production (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. Field Quality Control Test Reports.

G. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

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. Enclosure Keys: Two of each different key.

1.06 QUALITY ASSURANCE

A. Conform to 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.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchboards - Basis of Design: Square 'D'.

B. Switchboards - Other Acceptable Manufacturers:
   3. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 SWITCHBOARDS

A. Provide switchboards 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: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Front-Connected Switchboards:
   1. Main Device(s): Individually-mounted.
   2. Feeder Devices: Panel/group-mounted.
   3. Arrangement: Front accessible only (not rear accessible), rear aligned.

E. Service Entrance Switchboards:
   1. Listed and labeled as suitable for use as service equipment according to UL 869A.
2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.

F. Service Conditions:
1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
   a. Altitude: Less than 6,600 feet (2,000 m).
   b. Ambient Temperature:
      1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

G. Short Circuit Current Rating:
1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

I. Bussing: Sized in accordance with UL 891 temperature rise requirements.
1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
2. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

J. Conductor Terminations: Suitable for use with the conductors to be installed.
1. Line Conductor Terminations:
   a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   b. Main and Neutral Lug Type: Mechanical.
2. Load Conductor Terminations:
   a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   b. Lug Type:

K. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
2. Finish: Manufacturer's standard unless otherwise indicated.

L. Future Provisions:
1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.

M. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list switchboards as a complete assembly including surge protective device.

N. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
   2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
      a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
      b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

O. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

P. Owner Metering:
   1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
   2. Measured Parameters:
      a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
      b. Current (Amps): For each phase and neutral.
      c. Frequency (Hz).
      d. Real power (kW): For each phase, 3-phase total.
      e. Reactive power (kVAR): For each phase, 3-phase total.
      f. Apparent power (kVA): For each phase, 3-phase total.
      g. Power factor.
      h. Real energy (kWh).
      i. Power demand: Real, reactive, and apparent.
   3. Meter Accuracy: Plus/minus 1.0 percent.
   4. Features:

Q. Instrument Transformers:
   2. Select suitable ratio, burden, and accuracy as required for connected devices.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
   1. Interrupting Capacity:
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. 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. 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. Provide the following circuit breaker types where indicated:
1) 100 Percent Rated Circuit Breakers: Listed for application
   within the switchboard where installed at 100 percent of the
   continuous current rating.
d. 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) Pad-Lock Provision: For locking circuit breaker handle in OFF
   position.
3) Auxiliary Switch: SPDT switch suitable for connection to
   system indicated for indicating when circuit breaker has tripped
   or been turned off.

c. Provide the following circuit breaker types where indicated:
1) 100 Percent Rated Circuit Breakers: Listed for application
   within the switchboard where installed at 100 percent of the
   continuous current rating.
d. 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.

3. Insulated Case Circuit Breakers:
a. Description: Quick-make, quick-break, trip-free circuit breakers
   with two-step stored energy closing mechanism; standard 80
   percent rated unless otherwise indicated; listed and labeled as
   complying with UL 489; ratings, configurations, and features as
   indicated on the drawings.
b. Trip Units: Solid state, microprocessor-based, true rms sensing.
c. 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.

2.04 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Factory test switchboards according to NEMA PB 2, including the following
   production (routine) tests on each switchboard assembly or component:
1. Dielectric tests.
2. Mechanical operation tests.
3. Grounding of instrument transformer cases test.
4. Electrical operation and control wiring tests, including polarity and
   sequence tests.
5. Ground-fault sensing equipment test.
PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

B. Verify that mounting surfaces are ready to receive switchboards.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

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

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch (10 mm) between switchboard and wall.

E. Provide required support and attachment components in accordance with Section 26 05 29.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 30 00.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Install all field-installed devices, components, and accessories.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

L. Provide filler plates to cover unused spaces in switchboards.

3.03 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 reports with submittals.

C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

E. Inspect and test in accordance with NETA ATS, except Section 4.

F. Perform inspections and tests listed in NETA ATS, Section 7.1.

G. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and
circuit breakers larger than 200 amperes. Tests listed as optional are not required.

H. 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.

I. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

J. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10.

K. Test shunt trips to verify proper operation.

L. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.04 ADJUSTING

   A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
   B. Adjust alignment of switchboard covers and doors.

3.05 CLEANING

   A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.
   B. Repair scratched or marred surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

   A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
   B. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard and associated devices.
      1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.07 PROTECTION

   A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 26 24 13
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Power distribution panelboards.
B. Lighting and appliance panelboards.
C. Overcurrent protective devices for panelboards.

1.02  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 43 00 - Surge Protective Devices.

1.03  REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
B. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
D. NEMA PB 1 - Panelboards; 2011.
E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 67 - Panelboards; Current Edition, Including All Revisions.

1.04  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 the work with other trades to provide walls suitable for installation of flush-mounted panelboards 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 the contract documents. Obtain direction before proceeding with work.

1.05 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. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.

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. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

A. Conform to 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.

1.07 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.

1.08 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).

PART 2 PRODUCTS

2.01 MANUFACTURERS

C. Schneider Electric; Square D Products: www.schneider-electric.us.
D. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 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 indicated on the drawings.
   2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
   3. Label equipment utilizing series ratings as required by NFPA 70.

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. 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.
G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
   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 removable end walls for NEMA Type 1 enclosures.
      d. 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.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

J. 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.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
   1. Phase and Neutral Bus Material: Aluminum.

D. Circuit Breakers:
   1. Provide bolt-on type.
   2. Provide thermal magnetic circuit breakers unless otherwise indicated.
   3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
   1. Provide surface-mounted enclosures unless otherwise indicated.
2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards comply with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.05 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:
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. 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.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
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 Circuit Breakers: Designed to trip at 30 mA for protection of equipment.

c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.

d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.

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:

2.06 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
B. Verify that mounting surfaces are ready to receive panelboards.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.
B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer’s instructions and NFPA 70.
D. Provide required supports in accordance with Section 26 05 29.
E. Install panelboards plumb.
F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
G. 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.
H. 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.
I. 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.
J. Install all field-installed branch devices, components, and accessories.
K. Provide filler plates to cover unused spaces in panelboards.
L. 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. Intrusion detection and access control system circuits.
   4. Video surveillance system circuits.

3.03 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. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 200 amperes. Tests listed as optional are not required.
   D. Test GFCI circuit breakers to verify proper operation.
   E. Test AFCI circuit breakers to verify proper operation.
   F. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 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.

3.05 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
PANELBOARDS
26 24 16 - 8
PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Electrical connections to equipment.

1.02  RELATED REQUIREMENTS
   A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   B. Section 26 05 34 - Conduit.
   C. Section 26 05 37 - Boxes.
   D. Section 26 27 26 - Wiring Devices.
   E. Section 26 28 18 - Enclosed Switches.

1.03  REFERENCE STANDARDS
   A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
   B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
   C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04  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.

1.05  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.

1.06  QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2  PRODUCTS

2.01  MATERIALS
   A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
     1. Colors: Conform to 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 18 and in individual equipment sections.
C. Wiring Devices: As specified in Section 26 27 26.
D. Flexible Conduit: As specified in Section 26 05 34.
E. Wire and Cable: As specified in Section 26 05 19.
F. Boxes: As specified in Section 26 05 37.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 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 27 17
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Wall switches.
B. Receptacles.
C. Wall plates.
D. Poke-through assemblies.

1.02  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 37 - Boxes.
D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
E. 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.

1.03  REFERENCE STANDARDS

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.


1.04 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 installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
   4. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
   5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 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.

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. 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. Operation and Maintenance Data:
   1. GFCI Receptacles: Include information on status indicators.

G. 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 Surge Protection Receptacles: Two of each type.
   5. Extra Wall Plates: One of each style, size, and finish.

1.06 QUALITY ASSURANCE

A. Conform to 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 Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

C. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

2.02 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
D. Provide GFCI protection for receptacles installed within 6 feet (1.8 m) of sinks.
E. Provide GFCI protection for receptacles installed in kitchens.
F. Provide GFCI protection for receptacles serving electric drinking fountains.
G. Provide isolated ground receptacles for receptacles serving computers and electronic cash registers.
H. Unless noted otherwise, do not use combination switch/receptacle devices.

2.03 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.
B. Wiring Devices, Unless Otherwise Indicated: Gray with stainless steel wall plate. Provide Leviton Decora style devices and plates in exposed areas. Coordinate color selection for each space with the architect prior to procurement.
C. Wiring Devices Installed in Finished Spaces: White with stainless steel wall plate. Provide Leviton Decora style devices and plates in exposed areas.
D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
E. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.
F. Clock Hanger Receptacles: Brown with stainless steel wall plate.
2.04 WALL SWITCHES

A. Wall Switches - 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.

B. 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.

C. 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.

2.05 RECEPTACLES

A. Receptacles - 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.

B. Convenience Receptacles:

   1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.

   2. 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.

   3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

C. GFCI Receptacles:

   1. GFCI Receptacles - 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.


   3. 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 SE suitable for installation in damp or wet locations.

D. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.

2.06 WALL PLATES
A. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   3. Screws: Metal with slotted heads finished to match wall plate finish.
B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
C. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
D. Weatherproof 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.

2.07 POKE-THROUGH ASSEMBLIES
A. Manufacturers:
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.

PART 3 EXECUTION
3.01 EXAMINATION
A. 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.
B. Verify that wall openings are neatly cut and will be completely covered by wall plates.
C. Verify that final surface finishes are complete, including painting.
D. Verify that floor boxes are adjusted properly.
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.

3.02 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.

3.03 INSTALLATION
A. Perform work in a neat and workmanlike manner in accordance with NECA 1 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 37 as required for installation of wiring devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:
   a. Wall Switches: 48 inches (1.2 m) above finished floor.
   b. Wall Dimmers: 48 inches (1.2 m) 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. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.

4. 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.

5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

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. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

J. Install wall switches with OFF position down.

K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

L. 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.

M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

N. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.
3.04 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.

3.05 ADJUSTING
   A. Adjust devices and wall plates to be flush and level.

3.06 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
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Enclosed safety switches.

1.02 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 73 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.
   D. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS
   A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
   B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
   C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
   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.
   H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.04 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 the contract documents. Obtain direction before proceeding with work.
1.05 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.

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.

1.06 QUALITY ASSURANCE

A. Conform to 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.

1.07 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.

1.08 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

2.01 MANUFACTURERS


C. Schneider Electric; Square D Products: www.schneider-electric.us.
2.02 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. Provide with switch blade contact position that is visible when the cover is open.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: 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.

K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

L. Heavy Duty Switches:
   2. Conductor Terminations:
      a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      b. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

M. Provide the following features and accessories where indicated or where required to complete installation:
PART 3  EXECUTION

3.01  EXAMINATION

A. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
B. Verify that mounting surfaces are ready to receive enclosed safety switches.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02  INSTALLATION

A. Install enclosed switches in accordance with manufacturer’s instructions.
B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer’s instructions and NFPA 70.
D. Provide required supports 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.

3.03  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.
3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 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 18
ENCLOSED SWITCHES
26 28 18 - 6
SECTION 26 33 05

BATTERY EMERGENCY POWER SUPPLY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Emergency power supply.
B. Remote trouble alarm indicator.

1.02 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog and data sheets showing electrical characteristics and connection requirements. Include unit ratings, dimensions, and finishes. Include performance data for batteries.
C. 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.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 70.
1. Maintain one copy of each document on site.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.
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.

PART 2 PRODUCTS

2.01 EMERGENCY POWER SUPPLY

A. Description: NFPA 111 Type A, Class 1.5 stored emergency power supply system designed for Level 1 applications and consisting of rectifier/charger unit, storage battery, and solid state inverter with mechanical transfer switch, in one or several enclosures. Provide unit suitable for operating HID lamps without extinguishing lamp on transfer.
2.02 RATINGS

A. Input Voltage: 277 volts, 60 Hz, single phase.
B. Output Voltage: 277 volts plus 5 percent, single phase.
C. Inverter Output Frequency: 60 Hz plus 1 percent.
D. Efficiency: 90 percent minimum.
E. Maximum Recharge Time: 12 hours following 1.5 hour discharge.
F. Total Harmonic Distortion: Less than 10 percent at full resistive load.
G. Battery: Lead calcium, sealed type battery.
I. Instrumentation and Alarms: NFPA 111.
J. Charger: Dual rate, designed to maintain battery in full-charge condition during normal conditions.

2.03 REMOTE TROUBLE MONITOR

A. Instrumentation and Alarms: NFPA 111.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install units plumb and level.

3.02 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Verify operation of each unit by simulating outage.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
B. Demonstrate normal operation of unit.

END OF SECTION 26 33 05
SECTION 26 51 00

INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.
B. Emergency lighting units.
C. Exit signs.
D. Ballasts and drivers.
E. Luminaire accessories.

1.02 RELATED REQUIREMENTS

A. Section 26 05 37 - Boxes.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
C. Section 26 09 23 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.

1.03 REFERENCE STANDARDS

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
L. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.04 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 the contract documents to obtain direction prior to proceeding with work.
   5. All lighting fixtures and controls and installation shall comply with Title 24.

1.05 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.

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.
      2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.

D. Sustainable Design Documentation: Submit manufacturer’s product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.

E. Samples:
   1. Provide one sample(s) of each specified luminaire where indicated.

F. Field quality control 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. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

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 Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.

1.06 QUALITY ASSURANCE
   A. Conform to 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.

1.07 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.

1.08 FIELD CONDITIONS
   A. Maintain field conditions within manufacturer’s required service conditions during and after installation.

1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for all LED luminaires, including drivers.
   C. Provide five year pro-rata warranty for batteries for emergency lighting units.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES
   A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 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, 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. Recessed Luminaires:
   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.

H. 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.

I. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.

J. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 EMERGENCY LIGHTING UNITS

A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

C. Battery:
   1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

F. 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.

G. Where indicated, provide units with integral time delay to maintain emergency illumination for 15 minutes after restoration of normal power source.
2.04 EXIT SIGNS
A. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single or double as indicated or as required for the installed location.
   2. Directional Arrows: As indicated or as required for the installed location.
B. Self-Powered Exit Signs:
   1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
   2. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
   3. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.05 BALLASTS AND DRIVERS
A. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
B. Dimmable LED Drivers:
   1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
   2. Control Compatibility: Fully compatible with the dimming controls to be installed.
      a. Daylighting Controls: See Section 26 09 23.

2.06 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
3.01 EXAMINATION
A. 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.
B. Verify that suitable support frames are installed where required.
C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
D. Verify that conditions are satisfactory for installation prior to starting work.
3.02 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.

3.03 INSTALLATION
A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.
B. Install products according to manufacturer's instructions.
C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
E. 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 lay-in luminaires to ceiling support channels using listed safety clips at four corners.
   5. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
   6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
F. 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.
G. 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.
H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
I. Install accessories furnished with each luminaire.
J. Bond products and metal accessories to branch circuit equipment grounding conductor.
K. 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.

L. Install lamps in each luminaire.

### 3.04 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.

### 3.05 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.

### 3.06 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.

### 3.07 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 luminaires to Architect, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

### 3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

**END OF SECTION 26 51 00**
INTERIOR LIGHTING

26 51 00 - 8
SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Exterior luminaires.
B. Poles and accessories.
C. Luminaire accessories.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.
B. Section 26 05 37 - Boxes.

1.03 UNIT PRICES
A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
B. Exterior Lighting Unit:
   2. Basis of Payment: Includes concrete foundation, pole, and luminaire(s) with lamps and accessories.

1.04 REFERENCE STANDARDS
G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
I. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 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 the contract documents to obtain direction prior to proceeding with work.
   3. All light fixtures, controls and installation shall comply with Title 24.

1.06 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, 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 IESNA LM-63 standard format upon request.
   3. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

D. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.

E. 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.

F. Field Quality Control Reports.
   1. Include test report indicating measured illumination levels.

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, installation, and starting of product.

H. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
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 Lamps: Ten percent of total quantity installed for each type, but not less than two of each type.

1.07 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.08 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.

1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES
   A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 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:
      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. Exposed Hardware: Stainless steel.

2.03 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: 100 miles per hour (______ kph), with gust factor of 1.3.
      c. Dead Load: Include weight of proposed luminaire(s) and associated supports and accessories.
      d. Include structural calculations demonstrating compliance with submittals.
   3. Material: Steel, unless otherwise indicated.
   4. Finish: Match luminaire finish, unless otherwise indicated.

2.04 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.

PART 3 EXECUTION

3.01 EXAMINATION

A. 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.

B. Verify that suitable support frames are installed where required.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 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.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.
C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. 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.

F. 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 in length, with no more than 4 feet (1.2 m) between supports.

G. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

H. Pole-Mounted Luminaires:
   1. Maintain the following minimum clearances:
      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.
   4. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.

I. Install accessories furnished with each luminaire.

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

K. Install lamps in each luminaire.

3.04 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 conformance with performance requirements. Record test results in written report to be included with submittals.

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.06 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.

3.07 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 luminaires to Architect, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 56 00
SECTION 27 05 26

GROUNDING AND BONDING COMMUNICATION SYSTEM

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

1.02 SCOPE OF WORK

A. This section includes the minimum requirements for the equipment and cable installations in communications equipment rooms (Telecommunications Closets).

B. Included in this section are the minimum composition requirements and installation methods for the following:
   1. Busbars
   2. Bonding accessories

1.03 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufactures listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.

C. Material and work specified herein shall comply with the applicable requirements of:
   2. TIA – 569-B Commercial Building Standard for Telecommunications Pathways and Spaces, 2004

1.04 SUBMITTALS

A. Provide product data for the following:
   1. Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).
PART 2 – PRODUCTS

2.01 WALL-MOUNT BUSBARS

A. Telecommunications Main Grounding Busbar (TMGB)
   1. Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25” (6.4 mm) thick solid copper bar.
   2. The busbar shall be 4” (100 mm) high and 20” (510 mm) long and shall have 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
   3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 27 lugs with 5/8” (15.8 mm) hole centers and 3 lugs with 1” (25.4 mm) hole centers.
   4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4” (100 mm) standoff from the wall.
   5. The busbar shall be UL Listed as grounding and bonding equipment.
   6. Design Make shall be:
      a. Chatsworth Products, Inc. (CPI),
   7. Telecommunications Main Grounding Busbar:
      a. Part Number 40153-020, 20” x 4” (510 mm x 100 mm) Telecommunications Main Grounding Busbar, UL Listed.

B. Telecommunications Main Grounding Busbar (TMGB)
   1. Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25” (6.4 mm) thick solid copper bar.
   2. The busbar shall be 4” (100 mm) high and 12” (300 mm) long and shall have 18 attachment points (two rows of 9 each) for two-hole grounding lugs.
   3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 15 lugs with 5/8” (15.8 mm) hole centers and 3 lugs with 1” (25.4 mm) hole centers.
   4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4” (100 mm) standoff from the wall.
   5. The busbar shall be UL Listed as grounding and bonding equipment.
   6. Design Make shall be:
      a. Chatsworth Products, Inc. (CPI),
   7. Telecommunications Main Grounding Busbar:
      a. Part Number 40153-012, 12” x 4” (300 mm x 100 mm) Telecommunications Main Grounding Busbar, UL Listed.

C. Telecommunications Grounding Busbar (TGB)
   1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25” (6.4 mm) thick solid copper bar.
   2. The busbar shall be 2” (50 mm) high and 12” (300 mm) long and shall have 9 attachment points (one row) for two-hole grounding lugs.
   3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 6 lugs with 5/8” (15.8 mm) hole centers and 3 lugs with 1” (25.4 mm) hole centers.
   4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4” (100 mm) standoff from the wall.
   5. The busbar shall be UL Listed as grounding and bonding equipment.
   6. Design Make shall be:
      a. Chatsworth Products, Inc. (CPI),
   7. Telecommunications Grounding Busbar:
      a. Part Number 13622-012, 12” x 2” (300 mm x 50 mm) Telecommunications Grounding Busbar, UL Listed.
PART 3 – EXECUTION

3.01 INSTALLATION

A. Wall-Mount Busbars
   1. Attach busbars to the wall with appropriate hardware according to the manufacturer’s installation instructions.
   2. Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
   3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
   4. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.

B. Rack-Mount Busbars and Ground Bars
   1. When a rack or cabinet supports active equipment or any type of shielded cable or cable termination device requiring a ground connection, add a rack-mount horizontal or vertical busbar or ground bar to the rack or cabinet. The rack-mount busbar or ground bar provides multiple bonding points on the rack for rack and rack-mount equipment.
   2. Attach rack-mount busbars and ground bars to racks or cabinets according to the manufacturer’s installation instructions.
   3. Bond the rack-mount busbar or ground bar to the room’s TMGB or TGB with appropriately sized hardware and conductor.

C. Ground Terminal Block
   1. Every rack and cabinet shall be bonded to the TMGB or TGB.
   2. Minimum bonding connection to racks and cabinets shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
   3. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.

D. Pedestal Clamp
   1. At minimum, bond every sixth raised access floor pedestal with a minimum #6 AWG conductor to the TMGB or TGB using a pedestal clamp sized to fit the pedestal and the conductor and installed according to the manufacturer’s recommendations.
   2. If pedestal clamps are used to construct a signal reference grid, bond the signal reference grid to the TMGB or TGB and bond each rack and/or cabinet to the signal reference grid using a compression tap or similar non-reversible bonding component sized to fit both conductors.
   3. Remove paint between the pedestal and pedestal clamp, clean surface and use antioxidant between the pedestal and the clamp to help prevent corrosion at the bond.
   4. Remove insulation from conductors where wires attach to the pedestal clamp.

E. Pipe Clamp
   1. Bond metal pipes located inside the data center computer room with a minimum #6 AWG conductor to the TMGB or TGB using a pipe clamp.
sized to fit the pipe and the conductor and installed according to the manufacturer’s recommendations.

2. Remove paint between the pipe and pipe clamp, clean surface and use antioxidant between the pipe and the clamp to help prevent corrosion at the bond.

3. Remove insulation from conductors where wires attach to the pipe clamp.

F. Equipment Ground Jumper Kit

1. Bond equipment to a vertical rack-mount busbar or groundbar using ground jumper according to the manufacturer’s recommendations.

2. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or groundbar to help prevent corrosion at the bond.

END OF SECTION 27 05 26
PART 1  GENERAL

1.01  DESCRIPTION OF WORK

A. Cable tray shall be used to convey cable when outside of Telecom Utility rooms. This product shall NOT be used in Telecom and Server rooms (See Cable Runway).

B. Continuous, rigid, welded steel wire mesh cable management system.

1.02  REFERENCES


B. ASTM A 510 - General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.


1.03  DESIGN REQUIREMENTS

A. Maximum Deflection Between Supports: L/240.

1.04  SUBMITTALS

A. Comply with requirements of Section 01330 - Submittal Procedures.

B. Product Data: Submit manufacturer's product data, including UL classification.

C. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions, and accessories. Show layout, support, and installation details.

D. Manufacturer Qualifications: Submit manufacturer's certification indicating ISO 9002 quality certified.

1.05  QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9002 quality certified.

1.06  DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. Storage: Store materials in a dry area indoors, protected from damage, and in accordance with manufacturer's instructions.

C. Handling: Protect materials and finishes during handling and installation to prevent damage.

PART 2 PRODUCTS

2.01  MANUFACTURER

A. Cablofil, Inc., Flextray or approved equal.
2.02 CABLE MANAGEMENT SYSTEM

A. Description: Cablofil EZ Tray continuous, rigid, welded steel wire mesh cable management system.
   2. Safety Edge: Continuous safety edge T-welded wire lip.
   3. Wire Mesh: Welded at all intersections.

B. UL Classification: Straight sections 4 x 12 UL classified.

C. Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacturer.

2.03 FINISH FOR CARBON STEEL WIRE: FINISH APPLIED AFTER WELDING AND BENDING OF MESH.


B. Nominal Dimensions:
   1. Mesh: 4 x 12 inches and 18 inches
   2. Straight Section Lengths: 80 inches (2,000 mm) and 118 inches (3,000 mm).
   3. Width: 12 inches and 18 inches
   4. Depth: 4 inches (54 mm).
   5. Wire Diameter: 0.177 inch (4.5 mm), minimum.

C. Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.

   1. Wall Installation: FAS U 300 Bracket. Maximum tray width of 12 inches (300 mm).
   2. Ceiling Installation: FAS P400 16” FAS Profile for trapeze hung 12” tray, and FAS P550 Profile for trapeze hung 18” tray.
   3. Fasteners: As required by manufacturer. Furnished by manufacturer.

E. Hardware: Hardware, including splice connectors and support components furnished by manufacturer.

2.04 ACCESSORIES

A. Grounding: GTA-2-2 grounding lugs for attachment on tray of continuous ground conductor fixing system.

B. #4 Ground Bus cable with green jacket.

PART 3 EXECUTION

3.01 EXAMINATION

A. Exam areas to receive cable management system. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Install cable tray system at locations indicated on the drawings and in accordance with manufacturer's instructions.

B. Load Span Criteria: Install and support cable management system in accordance with span load criteria of L/240.
C. Cutting:
   1. Cut wires in accordance with manufacturer's instructions.
   2. Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.
   3. Cut each wire with 1 clean cut to eliminate grinding or touch-up.

D. Install cable management tray system using hardware, splice connectors, support components, and accessories furnished by manufacturer.
   1. UL Classified cable trays may act as Equipment Grounding Conductors.
      a. Use UL Classified splicing methods as recommended by Cablofil.
      b. Ground cable trays at end of continuous run.
      c. Ground continuous cable tray runs every 60 feet.
      d. Use #4 ground cable.
      e. Bond to building steel.

END OF SECTION 27 05 28
PART 1 GENERAL

1.01 DESCRIPTION

A. Furnish, install, and test a complete and functional communications infrastructure system to provide voice, and data communications.

B. Boxes and supporting hardware needed for pathway systems.

C. Furnish and install station cabling, faceplates, and jacks for connectivity of voice and data systems.

D. Furnish and install all racks, equipment grounding to bus bars, and other hardware needed to fully configure the Intermediate Cross connect (IR), and Telecommunications Cross connects (TR), Computer Labs, Instructional areas and Office’s for operation of the voice, and data systems described in this Section and shown on the Drawings.

E. Completely label and test all telecommunication cables and provide test documentation, and as-built drawings.

F. Furnish and install new fiber from the campus MDF to the new Telecom rooms shown on drawings, and provide as-built drawings.

G. Furnish and install new copper from the campus MPOE to new Telecom rooms shown on drawings, and provide as-built drawings.

1.02 SUBMITTAL

A. Prior to ordering any material, provide six (6) copies of complete brochure information on all products for installation on this project. All brochures and specification sheets shall be bound within a three-ring loose leaf binder and organized in the same manner as the products portion of the specifications. If more than one product is listed on the same page of the brochure or specification sheet submitted, the intended product or part number shall be clearly indicated or highlighted by the Contractor.

B. Contractor shall submit along with the materials submittal all proposed test procedures and a sample of the printout or test result form as well as a list of all Test Equipment to be used for cable testing. Within two (2) weeks of completion of testing all cabling systems, Contractor shall submit two (2) copies of the test results as directed in the Testing portion of the Specifications.

1.03 QUALITY ASSURANCE

A. Standards: The contractor will furnish without extra charge any additional material and labor which may be required for compliance with these laws, rules, and regulations, even though the work is not mentioned in these particular specifications.

1. The cable system shall meet the standards set forth in the American National Standards Institute / Electric Industries Association / Telecommunications Industry Association recommended standards

2. All cable installed under this specification shall be Underwriters’ Laboratories (UL) listed and certified to pass the appropriate UL test for cable designated for installation in plenum and riser spaces.

B. The telecommunication cable system shall conform to all applicable local codes and applicable sections of the California Electric Code, NFPA-70-2007.

C. Fire stopping shall be in accordance with ASTM E 814, ASTM E 136, and UL 1479 as well as Section 300-21 of the National Electric Code.

   1. IEEE 802.3 Carrier Sense Multiple Access With Collision Detection.
   2. FCC Rules and Regulations, Part 68.
   4. REA Cable Designations - PE Series Specifications

E. Conditions: Materials and equipment provided must be new products of manufacturers regularly engaged in the production of such products.

F. UL Listing: Products must be UL listed where a UL test procedure is applicable.

G. Telephone system materials and equipment shall be FCC Type-accepted and certified as such by supplier.

H. Qualifications: Contractor must have current Panduit Certified Installer Certificate (PCI) and be qualified to offer a Panduit Certification PLUS 25 year system performance warranty. The company must have a minimum of five (5) years experience in low voltage installations for voice, and data cabling systems.

I. Warranty: All repair, including labor and material, shall be made at no cost to the owner during the warranty period. All warranties shall be provided in writing to District prior to acceptance of the cabling system.

J. Contractor shall have the manufacturers representative provide periodic inspections of the cable system during the installation phase. Inspections will occur:
   1. After termination of jacks and before wall plates are installed.
   2. After termination of Patch Panels.
   3. After termination of fiber cable.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials in manufacturer’s standard protective packaging.

B. Do not remove protective packaging until ready for installation.

C. Follow manufacturer’s instructions for storage & handling.

1.05 CONTRACT DRAWINGS AND SPECIFICATIONS

A. The intent of the drawings and specifications is to establish the type of system and functions, but not to set forth each item essential to the functioning of the system. The drawings are generally diagrammatic and show approximate location and extent of work. In case of doubt of work intended, it is the responsibility of the Contractor to request instructions
from the Engineer or Owner prior to bid. The Contractor shall be responsible for installing a complete functioning system.

B. Contractor shall review all drawings and specifications before starting the work. Where discrepancies occur, Contractor shall immediately notify Engineer for clarification. Where discrepancies may occur between drawings and specifications, drawings are to be used for quantities while specifications are to be used for quality.

1.06 RECORD DRAWINGS

A. All drawings shall be submitted in hard copy with all field changes and contractor labeling indicated in red line updates. Upon completion of the project, Contractor shall deliver to Owner documentation of the project to include:
   1. As-built telecommunications floor plans of the facility with cable and outlet placement and full labels clearly depicted.
   2. As-built elevations of all termination fields describing cable and outlet location labeling scheme. Also any changes to the wall elevations and conduit placements in the Telecom rooms will be recorded on as-built drawings.
   3. As-built logical OSP and riser diagram describing connectivity and cable sizes (including copper and fiber) for both telecommunications and grounding cabling systems, and including as-built labeling of all OSP and Riser cables.

B. Cable test results shall be submitted in hard copy and magnetic format along with viewing software from the tester manufacturer. Hard copy to be bound within loose leaf binder and organized by serving MDF or IDF, room number of outlet location, and station identifier.

PART 2 PRODUCTS

2.01 INTERBUILDING BACKBONE COPPER CABLE

A. Filled ASP Twisted Pair Cable
   1. Conductors-Solid, annealed copper, 24 AWG.
   2. Insulation-Solid, high density polyethylene, color coded in accordance with telephone industry standards.
   3. Twisted Pairs-Insulated conductors are twisted into pairs with varying lay lengths to minimize crosstalk.
   4. Core Assembly-25 pairs & less: pairs are assembled together in a single group. More than 25 pairs are arranged in groups or binders, each binder having a color coded unit binder.
   5. Filling Compound-The entire core assembly is filled with ETPR compound, filling the interstices between the pairs and under the core tape.
   6. Core Wrap-Non hygroscopic dielectric tape applied longitudinally with an overlap.
   7. Aluminum Sheath-Corrugated, copolymer coated, 0.0008” aluminum tape applied longitudinally with an overlap. The sheath interfaces are flooded with an adhesive water blocking compound.
   9. 50-pair copper backbone to each TR

B. Acceptable Manufacturer: General Cable
2.02 HORIZONTAL COPPER CABLE

A. Description: 100-ohm, 4-pair UTP, binder groups covered with a thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-C for performance specifications.
   3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications, General Purpose: Type CM or CMG.
      b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
      c. Communications, Riser Rated: Type CMR, complying with UL 1666.
      d. Multipurpose: Type MP or MPG.
      e. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
      f. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

B. Guaranteed Published Channel Performance - ANSI/TIA-568-C.2 Category 6A / ISO 11801 Edition 2.1 Class EA - 10G UTP

1. Guaranteed Channel Performance - 85m
   a. The Category 6A/Class EA cabling channel solution shall be an end-to-end UTP cabling solution guaranteed to support 10GBASE-T to 100 m.
   b. The UTP channel shall exhibit superior Alien Crosstalk performance, improved Insertion Loss performance and guaranteed channel performance up to 500 MHz. The channel Alien Crosstalk performance shall be guaranteed for installed UTP channels with up to 4 connectors and up to 85 meters in length or 2 connectors and as short as 5 meters (3 meter permanent link).
   c. The channel performance (including Alien Crosstalk performance) shall be guaranteed for the worst-case six-around-one channel configuration, where the entire 90m permanent link length is in a structured (combed) bundle.
   d. Channel PSANEXT shall be guaranteed to be 2dB over the TIA/EIA & ISO/IEC Class EA limit from 1 to 500 MHz.
   e. Channel PSAACR-F shall be guaranteed to be 10 dB over the TIA/EIA & the ISO/IEC Class EA limit from 1 to 500 MHz.
   f. Channel Insertion Loss margin shall be guaranteed to be 3% over the TIA/EIA & ISO/IEC Class EA limit from 1 to 500 MHz.
   g. Channel NEXT margin shall be guaranteed to be 3.5 dB over TIA/EIA & 2.5 dB over ISO/IEC Class EA limit from 1 to 500 MHz.
   h. Channel PSNEXT margin shall be guaranteed to be 5.0 dB over TIA/EIA & 4.0 dB over ISO/IEC Class EA limit from 1 to 500 MHz.
   i. Channel PSACR-F margin shall be guaranteed to be 10.0 dB over TIA/EIA & ISO Class EA limit from 1 to 500 MHz.
   j. Channel Return Loss margin shall be guaranteed to be 3.0 dB over TIA/EIA & ISO Class EA limit from 1 to 500 MHz.
   k. The manufacturer shall provide Design and Installation guidelines to ensure that the minimum guaranteed performance margins are met.
   l. The cable shall consist of an outer jacket, tape consisting of discontinuation metallic elements, foam barrier, and 4-twisted pairs divided by a center cross web.
   m. The cable is a round design with a nominal outside diameter of 0.300 inches.
n. The cable, cordage, and connecting hardware shall be UTP components that do not include internal or external shields, or drain wires.

o. Category 6A cables shall have the following cable jacket for all outlets.
   1) Wireless Access Points - Green
   2) IP Cameras - Black
   3) Intercom/Clock/Bell - Orange
   4) Projectors - Blue
   5) Network Outlet - Blue
   6) VoIP - White


C. Mini-Com® TX6A™ 10Gig™ UTP Jack Modules shall be Category 6A performance featuring Split Foil MaTriX Technology. The eight position modules shall terminate unshielded twisted 4 pair, 22 - 26 AWG, 100 ohm cable and shall not require the use of a punchdown tool. Jack module shall use Enhanced Giga-TX™ Technology with forward motion termination to optimize performance by maintaining cable pair geometry and eliminating conductor untwist. The termination cap shall provide strain relief on the cable jacket, ensure cable twists are maintained to within 1/8” (3.18 mm) and include a wiring scheme label. The blue module base shall signify Category 6A performance and shall include a universal label representing T568A wiring schemes. The Mini-Com® TX6A™ Jack Modules include Split Foil MaTriX Technology on the external portion of the jack module, which assists in suppressing alien crosstalk. The jack modules shall be universal in design, including complying with the intermateability standard IEC 60603-7 for backward compatibility. Category 6A jack modules shall be UL and CSA approved and RoHS compliant.

1. The jack modules shall be ETL verified to ANSI/TIA-568-C.2 Category 6A and IEC/ISO 11801 Class EA channel performance. They shall be universal in design, accepting 2, 3, or 4-pair modular plugs without damage to the outer jack contacts. The jack modules shall be able to be re-terminated a minimum of 20 times and be available in 11 standard colors for color-coding purposes. The jack module shall snap into all Mini-Com® outlets, patch panels and surface mount boxes. The Mini-Com® TX6A™ 10Gig™ Jack Module must be installed as part of a complete Copper Cabling System in order to achieve 10GBASE-T certified performance.

2. Keyed option available - Color-specific keys with positive and negative keying features mechanically and visually distinguish connections to prevent unintentional mating with unlike keyed or non-keyed modular plugs, offering network design flexibility, versatility, accommodating discrete networks for enhanced security.

2.03 FIBER OPTIC CABLES

A. Outside Plant Fiber Optic Cable
   1. All Multimode Fiber cable will be 50/125 micron, 18 strand.
   2. All Singlemode Fiber cable will be 8.3/125 micron, 18 strands.
   3. All OSP fiber shall be loose tube, all dielectric, armored outdoor cable.
   4. All Riser cable shall be tight buffered all dielectric, Indoor/Outdoor cable.
   5. The multimode fiber cable must comply with the following minimum transmission parameters of 40Gbe and 100Gbe
6. Outdoor design shall offer water blocking for aerial and duct applications for standards compliance and flexibility for outdoor use.

7. Bend radius: Dynamic: 20 x Cable O.D.; Static: 10 x Cable O.D.

8. Acceptable manufacturers of fiber cable are Panduit:
   a. 50/125um (OM3) Multimode
      1) Part number: FOQNX**
   b. 9/125um (OS1) Singlemode
      1) Part number: #FSWN9**

2.04 PATCH CABLES, PATCH PANELS, & TERMINATION HARDWARE

A. TX6A™ 10Gig™ Patch Cords shall be constructed with Category 6A 23-AWG stranded cable featuring MaTriX Technology. Patch Cords shall be factory terminated with modular plugs featuring a one-piece, tangle-free latch design and black strain-relief boots to support easy moves, adds and changes. TX6A™ 10Gig™ Patch Cords have incorporated MaTriX Technology and a barrier tape into the patch cable design to help suppress alien crosstalk and improve internal electrical performance. Patch cords shall be wired to be compatible with both T568A wiring schemes. The patch cords shall come in standard lengths of three to twenty feet (one-foot increments) and twenty-five to fifty feet (five-foot increments). The patch cords are available in eight standard colors of White, Blue, Yellow, Green, Black, Red, Violet, and Orange.

B. The patch cords shall be ETL verified ANSI/TIA-568-C.2 Category 6A and IEC/ISO 11801 Class EA channel performance. Each patch cord shall be 100% performance tested at the factory in a channel test to the ANSI/TIA-568-C.2 and IEC/ISO standards. The TX6A™ 10Gig™ Patch Cords must be installed as part of a complete TX6A™ 10Gig™ UTP Copper Cabling System in order to achieve 10GBASE-T certified performance.

C. Patch Cords shall be Owner furnised/Owner Installed (OFOI)

D. Part numbers:
   1. UTP6A3**
   2. UTP6A7**
   3. UTP6A9**
   4. UTP6A14**
   5. UTP6A20**

6. Patch cables shall be provided in various lengths to be determined by the Contractor and owner representative such that the cables can be routed from data outlet to workstation device with sufficient slack for moderate workstation device movement.

7. TC patch cables shall be provided in various lengths to be determined by the contractor & owner, such that the cables can be routed within the cable management hardware without crossing any other patch panel unnecessarily and to allow easy connection at each end, with minimal additional cable requiring storage within the cable management hardware.

E. Cross Connect Wire

   1. Reels of telephone cross-connect wire shall be provided for connection of the voice feeder and voice station blocks within the IC/TC room
   2. Wire shall be solid, 24 AWG, one-pair, copper conductors insulated with industry standard color-coded PVC. Provide cross connect wire in reels containing one thousand feet (1000') of wire.
3. Cross Connect Wire shall be of the same manufacturer as Multi-pair Copper Voice Riser Cable manufacturer.

F. Grounding Conductors
   1. Bare stranded copper ground conductors shall be provided and installed by the Contractor as shown on the project drawings to provide a grounding system consistent with the 1999 National Electric Code as well as EIA/TIA 607.
   2. Ground conductors shall be minimum 4 AWG between MDF & IDF Closets, and the Building Service Ground point and minimum 6 AWG between hardware components located within the MDF & IDF closets.

G. Fiber Optic Enclosures
   1. OPTICOM™ Rack mounted fiber optic enclosures shall be designed to manage and organize fiber optic cable to and from the equipment or cabling plant. Enclosures shall protect fiber optic connections for patching or splicing requirements. Enclosures shall accommodate up to 36 fibers (with Fiber Jack, LC) per rack space and shall be constructed of steel material. Enclosures shall have removable front and rear covers and top and bottom pass through holes.
   2. Part Number: #FRME1

H. Category-6A Patch Panels
   1. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
      a. 24 and 48 port patch panels that accept Category 6A modular jacks with IDC connector terminations on rear
      b. The patch panel shall have electrical performance guaranteed to meet or exceed TIA/EIA 568-C.2 Category 6A and ISO/IEC 11801 Edition 2.1 Class EA component and channel specifications.
      c. The panel shall have vertical and horizontal cord organizers available as to improve patch cord management.
      d. The panel shall be available in flat and angled 24-port 1RU and 48-port 1RU and 2RU configurations.
      e. Each modular jack in the panel shall come with universal A/B labeling and IDC termination that ensures 22 to 26 AWG cable conductors are fully terminated by utilizing a termination cap design and terminates to the modular jack through a smooth forward motion without impact on critical internal components for maximum reliability.
      f. Each modular jack shall be 100% performance tested, capable of being re-terminated up to 10 times and identified with the performance level and with an individual serial number for traceability.
      g. The panel shall have a black powder finish over high-strength steel.
      h. The panel shall have a labeling option to comply with TIA/EIA-606-A.
      i. The panel shall be equipped with a removable rear mounted cable management bar and front and rear labels.
      j. The panel shall be UL listed, UL-C certified and ACA approved.
      k. The panel shall support network line speeds in excess of 1 and 10 Gigabit per second and be backward compatible with Category 6, 5e, 5 and 3 cords and cables.
I. The Category 6A punchdown patch panels shall meet or exceed the Category 6A/Class EA standards requirements in ISO/IEC 11801, TIA/EIA-568-C and shall be UL Listed.

m. The panels shall be 19-inch rack mountable.

I. 24 and 48 port patch panels with front patch cord retainer & rear cable retainer:
   1. The Category 6A modular jack panels shall meet or exceed Category 6A standards requirements in ANSI/TIA-568-C.2 and Class EA in Amendment 1 to ISO/IEC11801 Edition 2.1 shall be UL Listed.
   2. The modular jack panel shall utilize universal A/B wiring.
   3. The jack panels shall be 19-inch rack mountable.
   4. Four-pair Category 6A UTP cabling shall be terminated onto a four-pair Category 6A module. All modules shall be terminated using the T568A wiring scheme. The eight-position module shall exceed the connector requirements of the TIA/EIA Category 6A standard. The module termination to four-pair, 100 ohm solid unshielded twisted pair cable shall be accomplished by use of a forward motion termination cap and shall not require the use of a punchdown or insertion tool.

J. Terminations
   1. Termination on patch panels should be by Room number of the destination work area, Station number, Jack number (Prefixed with type "V" for voice, and "D" for data)
   2. Voice, data and security/emergency notification system jacks shall terminate on different patch panels. All voice together, all data together and all security/emergency notification system together.
   3. Punch down order on patch panels for copper cabling shall be by room signage, not architectural room numbering, then location within the room, then drop at location.

K. TELECOMMUNICATIONS WORKSTATION OUTLETS
   1. Voice/Data outlets will be of modular design, color-coded to distinguish between data service and Wireless data service. Each outlet shall be configured with Modular 8-Pin jacks wired to the T568A pin assignment sequence.
   2. Acceptable Manufacturers: Panduit MINI-COM Executive Series Faceplate
   3. All wall face plates will match the color of the electrical cover plates and have 4 ports minimum
   4. Copper Protector Panel: Use Circa 1880ENA1-25G, 1880ENA1-50G and 1880ENA1-100G.
      b. Copper Splice Case: Preform Stainless Steel or equal. Size as required.
      c. Copper Splice Module: Use Systimax 710-SLC-25 filled modules or engineer approved equal.

PART 3 EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. Contractor shall give notice to all agencies requiring advance notification and comply with all regulations specified by all governing agencies having jurisdiction over the performance of the work.

B. Contractor shall coordinate with and abide by the construction schedule and sequencing as dictated by the General Contractor on the project.
Storage and staging areas within the job site shall be as dictated by the
General Contractor.

C. The owner shall provide and pay all permits.

D. The contractor shall provide all labor, materials, equipment, tools, utilities
and services necessary for the proper execution and completion of the
telecommunications cabling system.

3.02 INSTALLATION METHODS

A. Contractor is required to adhere to the following parameters whether or not
Contractor and/or others have placed existing equipment. Contractor will
notify the owner of any of the following requirements that cannot be met
prior to bid or ordering of materials.

B. General: Install an infrastructure cabling system as detailed by the contract
drawings, details, and specifications.

C. The maximum length of horizontal cabling from nearest closet to an outlet
shall not exceed 279 feet as per EIA/TIA 568. Contractor will notify The
owner prior to commencement of any installation not meeting the 279-foot
maximum distance limitation.

D. Contractor will place all station cables in the ceiling area on Contractor
supplied and installed cable tray and in conduits or in floor spaces and
raceways. Contractor also will assess whether or not the ceiling space is a
plenum air return, which shall dictate the use of the listed plenum type, or
PVC type cable required in the materials specification section. The cables
will be routed to the IDF located on the each floor, utilizing cable tray.
Strapping to any other wires (e.g., lighting, ceiling grid, J-hooks, etc.) is not
permitted. Cable splicing at any point of a station cable is unacceptable.
When cables are routed in non-ceiling spaces, such as below raised
flooring, the Contractor will still assess whether or not the space is a
plenum air return and pull the appropriate cable type.

E. In hard wall (wallboard) or V wall type construction where accessible,
Contractor will install a wall board adapter or equivalent, which will support
mounting of the faceplate necessary for the jacks. This will eliminate the
need for an electrical box (in-wall junction box) to accommodate the
communications outlet.

F. Cables will be run vertically in 1.25” (inch) dedicated EMT conduit inside the
wall and into the ceiling space. Once in the ceiling space, the cable will be
routed to the closest cable tray. Cables shall be routed to their closest IDF
utilizing the shortest path possible, while still following EIA/TIA standard
guidelines. Station cables outside of cable tray must be ran in conduit, 1"
minimum. Strapping to any other wires (e.g., lighting, ceiling grid, etc.) is
not permitted.

G. In areas where modular furniture is installed or in areas where office
furniture is in an open office space, telecommunications cabling access will
either be through the floor or from the ceiling.

H. Where the cable access is from a duct under the floor, the Contractor will
provide and install mounting hardware inside the floor box that will support
the outlets.

I. The Contractor will provide and install a plastic spiral wrap device or metal
flexible conduit to the cable channel in the furniture or to a surface mount
box located at each work station. The Contractor shall coordinate with the owner, the exact location of each cable termination and jack location.

J. UTP cabling must conform to a 6-foot separation requirement from main power panels, switch gear and/or starter motors.

K. All power feeds crossing the path of the UTP cables at right angles must be a minimum of 6 inches in distance from the UTP cables.

L. Cables shall be run cable tray in corridors wherever possible in order to avoid furniture and work areas so that access to the cables is unencumbered.

M. The cables shall be placed at a minimum of 6 inches above the ceiling.

N. The cables are to be run so as to maximize accessibility. Contractor will notify the owner in the event this requirement cannot be met.

O. Debris, boxes, leftover cables, and trash must be removed from construction sites upon completion of work. No debris or work material may be left in areas that have student access unless the affected area is marked with cones, tape, or temporary fencing.

P. Contractor shall pull conductors together where more than one is being installed in a raceway. Cable bundles in raceways, in suspension systems, or on wallboards must be velcro wrapped every 5 feet. There must be an independent system supporting the cable system. Cable bundles tied to the lighting-ceiling grid will not be permitted. Station wire cannot be attached to electrical conduit, gas or sprinkler piping, or other code-restricted items.

Q. No cabling is allowed to rest on any ceiling tile or suspension system. Cable shall be kept 30 inches away from any heat source; i.e., steam valves, etc.

R. Cables shall be pulled free of sharp bends or kinks, twists, or impact damage to the sheath.

S. Cables shall not be pulled across sharp edges. Cables shall not be forced or jammed between metal parts, assemblies, etc.

T. Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems must be maintained.

U. Insulation shall be removed to expose shielding and conductors to the exact length required by manufacturer for proper termination of plugs and pins. Plugs and pins, upon termination, shall not be damaged in any way.

V. All communications racks must be properly anchored to walls and floors and grounded to building ground grid (not to water pipes, etc.).

W. Cable splicing will not be permitted in any horizontal cable run.

X. Contractor shall install system using tools and equipment specifically designed for the installation tasks. Use installation practices that ensure the highest quality installation. Perform all cutting, splicing, pulling and termination of cables using equipment specifically designed for each purpose.

Y. Install hook and loop fasteners only; velcro wraps. Zip ties are not permitted.

Z. Where multiple conduits are being used, fill one conduit to its maximum fill ratio before going onto the next conduit. Wherever possible, leave as many spare conduits available as possible.
AA. All cables requiring lubrication for installation in conduits shall be continuously lubricated during the pulling-in process. Maximum pulling tensions specified by the cable manufacturer shall not be exceeded. Monitor cable-pulling tension with a mechanical tension-indicator.

AB. All new conduit will not exceed a 40% fill rate. All spare conduits or conduits filled with cabling shall have a pull string installed and left for future installation of cable. Clearly label as "pulling line" indicating To/From.

AC. Install the telecommunication cabling system as detailed in the contract drawings in the exact location and layout shown in the details.

AD. Openings around electrical raceway penetrations shall maintain the fire resistance rating required. See NEC 300-21.

AE. Label all cables at both ends. The label shall be permanent. Labels shall be typed (not handwritten) and individual number strips are unacceptable. An acceptable labeling product is a self-laminating cable marker, such as Brady Design-BuilderT-9-292-series. All cable labeling shall include numeric designation, source, destination, cable type, and conform to the District-wide labeling standards and labeling scheme.

AF. All outlet plates shall be installed neatly and square with floor and walls.

AG. Category 6A installations shall conform strictly with EIA/TIA 568A and TSB-40B to insure a quality system that meets the transmission rate criteria.

AH. Patch panels should be installed in 2-post racks only. 4-post racks are exclusively for equipment.

AI. Punch down order on patch panels for copper cabling shall be by room signage, not architectural room numbering, then location within the room, then drop at location.

AJ. When cable runs are being installed, provide adequate service loops at ends to accommodate future cabling system changes. The recommended minimum amount of slack is 6 feet for UTP cables in the TR and 10 feet for fiber optic cables in the TR.

AK. Place outside plant copper and fiber cabling to allow for service loops in each maintenance hole and 15 feet at each TR.

3.03 FIBER OPTIC CABLE SYSTEM

A. The fiber optic raceway system must be continuous between pull boxes and junction boxes. The raceway system must enter and be secured to enclosures.

B. All fiber supplied to the campus, must be tested with an OTDR, Microtest Certifier, or equal prior to installation, while still on the shipping reel, using an optical time domain reflectometer (OTDR) or a 850/1300/1510 nm power meter and stabilized light source. The test results must be compared to the manufacturer's test results. A discrepancy of more than 1 dB on any fiber in either window indicates possible shipping damage and the fiber must be returned to the supplier.

C. All fiber must be tested after installation according to the procedures and acceptability criteria described in EIA/TIA 455A (Aug 1991) and all applicable addenda after installation and termination using an OTDR in one direction and an 850/1300 nm power meter and stabilized light source in
both directions and in both optical windows. The results of these tests (printed OTDR results and tabular loss results) must be provided by the installer as documentation of the quality of installation and as a baseline for future troubleshooting. The results must be compared to the pre-installation test results for significant changes.

D. All optical test equipment must have current, traceable calibration certification.

E. All spare optical ports and connectors should have a dust cap in place to protect the cable from the environment.

F. Manufacturer’s specification for pulling stress and minimum bend radius must not be exceeded on any fiber cable.

G. Installation contractor must develop and review conduit installation plan with the owner before beginning installation.

H. Installation contractor must verify all device locations with the owner before installation.

I. Installation contractor must review cable numbering and labeling scheme with the owner prior to installation.

J. Installation contractor must review drawing notes and drawing back-annotations (red line) on site plans with the owner prior to installation.

K. Fiber Optics Cable Labeling: Fiber termination locations must be labeled to corresponding fiber strands pairs at the Main Cross-connect (MC), Intermediate Cross-connect Room (IR), and the Telecommunications Room (TR). Use embossed labels. The Contractor is expected to provide tags, straps, and adhesive labels. These tags, straps, and adhesive labels must be of high quality that will endure over time. Hand written labels are not acceptable. All fiber cable numbering and labeling will conform to the District-wide labeling standards and labeling scheme.

L. All outside fiber cable will be installed through 1.25” innerduct from point of origin and destination.

M. Securely fasten the fiber optics raceway to the cable tray, or walls when routed inside buildings, using clamps and clips designed for this purpose.

N. Provide a nylon or polyethylene pulling line in all fiber optics raceways. Clearly label as “pulling line”, indicating source and destination.

O. Openings around fiber optics raceway penetrations shall maintain the fire resistance rating required. See NEC 300-21.

P. All fiber optics cables are to be run as efficiently as possible, minimizing the amount of cable required.

Q. All fiber optics cables shall be continuously lubricated during the pulling-in process. The maximum pulling tensions specified by the cable manufacturers shall not be exceeded. Monitor cable pulling tension with a mechanical tension meter.

R. The fiber optics cables passing through pullboxes and manholes shall be neatly arranged and secured to cable jacks on the interior walls. Cables will not be accepted when diving through the manhole or pullbox.
S. As fiber optics cables emerge from intermediate-point pull boxes, coil the cable in a figure eight pattern with loops not less than two feet in diameter.

T. Label all fiber optic cables at both ends. The label shall be permanent. Labels shall be typed (not handwritten) and individual number strips are unacceptable. All cable labeling shall include numeric designation, source, destination, and cable type. All fiber cable numbering and labeling will conform to the District-wide labeling standards and labeling scheme.

U. Fiber optics raceways shall be clearly marked at each pull box indicating type and number of cables within.

V. If connectors have been factory installed on fiber optic cables, protect the connector during the pulling-in by wrapping with a thin layer of foam and insert in a stiff plastic sleeve for protection.

3.04 OUTSIDE PLANT INSTALLATION

A. The following specifications will be adhered to when splicing copper cable runs. These specifications and standards apply for all splicing situations, including:
   1. Manhole Splices and Splice Cases
   2. NEMA Enclosure Splices and Splice Cases
   3. MC/IC Splices and Splice Cases
   4. MC/IC Electrical Protection Splices

B. The Contractor will splice all the cable pairs within each cable sheath using AT&T 710-SC1-25 Splice Modules, including cable pairs that will not be connected at this time. All splices shall be secured in a splice case using a preformed splice case. All splices and the installation of the splice case shall be in accordance with the manufacturer's specifications and GTE Practice, Section 632, ensuring a watertight seal. The Contractor will bond the cable's metallic sheath/shield to the metallic splice case with the bonding bar assembly provided with the splice case. No filling compound is to be used in the splice enclosures; therefore the Contractor must take special care while assembling the case.

C. All copper and fiber cables passing through a manhole or pullbox will be dressed neatly to the inside walls with "L" brackets designed for securing cable in manholes and pullbox's. Cable that is not secured and routed properly will be removed and redone at no expense to the owner.

3.05 GROUNDING

A. Grounding shall be accomplished by common single-point termination of all ground conductors.

B. All metallic components of the infrastructure system shall be solidly grounded by the shortest possible route.

C. Manhole Splices and Splice Cases - the Contractor will connect the splice case to the manhole ground as per GTE practice 605-100-201 using a #6 AWG solid copper wire.

D. NEMA Enclosure splices and Splice Cases - the splice case must be grounded to the provided ground lug in the existing NEMA box with a minimum #6 AWG wire.

E. MC/IC Splices and Splice Cases - the splice case must be grounded to the provided ground bar in the Voice/Data Equipment Room with a minimum #6 AWG wire.
F. MC/IC Electrical Protection Splices - the Contractor must bond the cable's metallic sheath/shield to the metallic splice case with the bonding bar assembly provided with the splice case.

G. Labeling: The splice case and all cables must be labeled using a stamped metal plate or indelible plastic plate, that the owner has approved, which details exact pair counts and destinations. Each 25-pair binder group, of each cable entering the splice case, must be labeled with a Panduit PAN-TY PLF1M-0 Flag with appropriate cable pair counts. All copper and fiber cable numbering and labeling will conform to the District-wide labeling standards and labeling scheme.

H. Conduit Sealing: The Contractor will supply and install all necessary components to effectively seal all conduits. The Contractor will use Semco part #PR-851 conduit sealing kit. The PR-851 compound is a two part polyurethane foam, which, when mixed for fifteen seconds, expands approximately fifteen times in volume. It forms a dense, tough foam with a density of three to four pounds per cubic foot. The expanding nature of the compound allows it to fill cracks and voids in conduit walls, and imperfections in the cable sheath. This effectively seals the conduit against the passages of gases and water. For additional information, refer to GTE Practice 628-020-203.

3.06 LABELING

A. All telecommunications infrastructure and equipment components shall be labeled according to TIA/EIA 606A standards

1. Backbone Copper Riser Terminal Labeling
   a. Backbone copper riser terminal blocks shall be labeled with the cable number and the pair counts indicated on the designation strip

2. Fiber Optic Labeling
   a. Each strand of fiber optic cabling will be labeled on the patch panels at both ends with the local termination point and the destination termination point
   b. Each fiber cable, before breakout, shall be labeled at both ends with the local termination point and the destination termination point

3. Horizontal Cable Termination
   a. Room number of the destination work area, station number, jack number (prefix "V" for voice, "D" for data). Voice and data jacks terminate in different patch panels; all voice together and all data together and all CCTV together.

4. Horizontal Outlet Labeling
   a. Labeling must be done in ascending campus room number, not drawing or architect room numbers. No tables or translations will be accepted
   b. TR room number, room number of the work area, station number (Example: 109 122-1-D1) 109 is the TR, 122 is the room where the jack is located, 1 is the station location, D1 is the first data jack in that particular wall plate.
   c. All labeling shall be done with typed inserts, typed on adhesive labels, or pre-stamped jack usage indicators for patch panels. For cabling the labeling shall be printed heat shrink labels or typed adhesive labels specifically designed for cabling. Handwritten labels are not allowed.
d. Post one full size plot (42X30) of as-built drawings, specifically the floor plans, and reflected ceiling plans, within IDF’s such that show the IDF’s serving area, Coordinate location of posting wit Owner.
e. Submit a "cable ID-to-Office number key" as an electronic file in the MS-Excel spreadsheet file format containing a list of every cable identifier associated with the final office number. This should be the Jack Table.

3.07 FIRE STOPPING

A. Clean surfaces to be in contact with fire stopping materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting or the required fire resistance.
B. Install fire stopping materials as indicated, in accordance with manufacturers instructions.
C. Seal all holes or voids made by penetrations to ensure an effective smoke barrier.
D. Unless protected from possible loading or traffic, install fire stopping materials in floors having void openings of 4 square inches or more to support the same floor load requirements.
E. A small amount of hydrogen gas is released as foam cures. Use forced air ventilation when installing if areas of installation have less than 2 cubic feet of free air for each pound of liquid mixture being foamed.
F. Examine fire stopped areas to ensure proper installation prior to concealing or enclosing fire stopped areas.
G. Areas of work shall remain accessible until inspection (and approval) by the applicable code authorities.

3.08 CABLE AND RACEWAY MARKING

A. Provide legible and indelible marking on all cables as indicated in the Drawings. Contractor shall insure labeling of the cables during installation.
B. Raceways shall be clearly marked at each pull box indicating type and number of cables within.

3.09 SYSTEM TESTING

A. The Contractor shall be responsible for separately testing and documenting the cables and termination throughout the entire cabling system. Ensure that the cable and equipment being installed in the system is without flaw and that no potential damage to the cable or equipment occurred in shipment, handling, or installation. The owner representative shall observe the testing of the installed cabling and terminations at any time during the testing process.
B. Testing of all installed unshielded twisted pair telecommunications cabling shall be performed by the Contractor. Interim testing of the cabling system during and after installation is encouraged to ensure that the testing and acceptance criteria are met.
C. Acceptance of the Telecommunications Cabling System shall be based on the quality of Contractor performance by analysis/inspection of the testing program documentation and the conformance of the system operation with the criteria described herein. Contractor shall make available all drawings and documentation prior to acceptance testing.
D. Contractor shall provide all necessary testing equipment for performing the required acceptance test. Contractor shall verify the authenticity and display appropriate calibration data to include the expiration date of the correct calibration.

E. Testing methods are provided herein as reference for the Contractor. Test equipment, methods, and criteria shall comply with the guidelines set forth in EIA/TIA TSB - 67 - Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems where applicable.

F. Copper Cable Testing:
1. Contractor shall perform final testing on the copper cable system to demonstrate the acceptability of the project as installed. Contractor shall perform and furnish documentation of the following tests:
   a. Continuity of all conductors.
   b. Shorted conductors or pairs.
   c. Crossed pairs.
   d. Grounded conductors.
   e. Open conductors.
   f. Reversed pairs.
   g. Split pairs.
   h. NEXT performance.
   i. Length.
   j. Attenuation.
   k. AC voltage presence.
   l. Pin-assignment confirmation
2. Results of the testing shall be furnished in printed format. All test documents shall be dated and signed by the personnel performing the testing. Hand-written test results are not acceptable. Test gear used for general testing shall be Tektronix TPS 100 Twisted Pair Cable Analyzer or approved similar device.
3. Test results shall document each installed cable pair for measured attenuation and Near End Cross Talk (NEXT). Category 6A testing shall utilize a Fluke 4000 Category 6A Scanner or approved similar device for performance validation. Category 6A End to End Link Performance shall be in accordance with the specification set forth in ANSI/TIA/EIA-568-A as well as meeting the documents’ requirements for cabling length and topology, component performance and reliability, and installation practices.
4. Contractor shall be responsible for recording all test results. Copies of these test results shall be submitted to The owner for review prior to final acceptance of the copper cabling system.
5. The contractor shall perform all tests and adjustments, and shall furnish all test equipment necessary and perform all work required to determine or modify performance of the system in accordance with these specifications. The contractor will submit to the owner a complete test plan for Station Wiring/Information outlet (Voice, Data and Network), and Riser Cable to be used for this contract. At a minimum, the plan should show test configurations, calibration procedures, impedances, and measurement equipment. This plan must be approved by the owner prior to the start of testing. The test plan is a one-time requirement and will remain in effect for the duration of this contract unless specifications change requiring a re-submittal. The scope of this work includes, but is not limited to, the following:
a. Testing of Category 6A cable shall meet EIA/TIA 568A Requirements.
b. The vendor must utilize a check-off list for reference by the owner during tests.
c. The vendor must utilize a check-off list for reference by the owner during tests.
d. The result of the measurements outlined shall be recorded and submitted to the owner as final proof of system performance. Electronic results will be supplied in Fluke or equivalent format. If the owner requires specific software to view the results, the contractor will supply a copy of software to the owner.
e. All systems must pass Category 6A specifications and be accepted by the owner before the work will be considered complete.
f. Inter- and Intra-building tie cables: all tie cables will be tested for pass-fail connectivity ground continuity.
g. Any link reporting a fail must be reterminated and retested.

3.10 FIBER CABLE TESTING

A. Test all fiber with an OTDR, Microtest Certifier or equal, prior to installation while fiber is still on the shipping reel, using an optical time domain reflectometer (OTDR) or a 850/1300/1510 nm power meter and stabilized light source. Compare test results to the manufacturer’s tests. A discrepancy of more than 1 db on any fiber in either window indicates possible shipping damage and the fiber must be returned to the supplier. Contractor shall keep test results on file for future reference.

B. Test all fiber after installation according to procedures and criteria described in EIA/TIA 455A and all applicable addenda after installation and termination using an OTDR in one direction and an 850/1300/1510nm power meter and stabilized light source in both directions and in both optical windows.

C. All optical test equipment must have current, traceable calibration certification.

3.11 TEST DELIVERABLES

A. Contractor shall submit a complete test plan for station and riser wiring. At a minimum, the plan should show test configurations, calibration procedures, and measurement equipment. The plan must be approved by the owner prior to the start of testing.

B. Printed ODTR results and tabular loss results must be submitted by the Contractor as documentation of the quality of the installation and as a baseline for future troubleshooting. Compare results to pre-installation tests and document significant changes.

C. Four (4) copies of the general Copper, Category 6A, and Fiber ODTR results shall be submitted in a tabular, typewritten format at the completion of system testing. The test results must also be provided in an electronic file for future reference.
SECTION 27 11 16

CABINETS, ENCLOSURES AND RACKS

PART 1 GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and
      Supplementary Conditions and other Division 1 Specifications, apply to this
      Section.

1.02 SUMMARY
   A. Section Includes:
      1. Free-standing Equipment Cabinets, Enclosures or Racks.

1.03 REFERENCES
   A. ANSI/EIA RS-310-C - Rack mounting standards.
   B. NEMA 250 - Enclosures for Electrical Equipment 1000 V Max.
   C. Strictly adhere to all Building Industry Consulting Service International
      (BICSI), Electronic Industries Alliance (EIA) and Telecommunications
      Industry Association (TIA) recommended installation practices when
      installing communications/data cabling.
   D. Material and work specified herein shall comply with the applicable
      requirements of:
      1. ANSI/TIA/EIA – 568-B Commercial Building Telecommunications
         Cabling Standard, 2000-2004
      2. TIA – 569-B Commercial Building Standard for Telecommunications
         Pathways and Spaces, 2004
      3. ANSI/TIA/EIA – 606-A Administration Standard for the
         Telecommunications Infrastructure of Commercial Buildings, 2002
         (Earthing) and Bonding Requirements for Telecommunications, 2002
   E. CEC - California Electrical Code - application, and installation of electrical
      cabinets and enclosures.
   F. UL 50 - Cabinets and Boxes.

1.04 SUBMITTALS
   A. Conform to the requirements of section 280500, General Requirements.
   B. Product Data: Submit manufacturer's technical data for all items to be
      used including specifications, installation instructions and general
      recommendations.

1.05 SITE CONDITIONS
   A. Cabinets shown on the Drawings are in approximate locations, actual
      location within the same room may depend on site conditions and Facility
      approval.
PART 2 PRODUCTS

2.01 EQUIPMENT RACKS

A. Racks shall be rectangular in shape, manufactured from steel, welded construction with two pairs of removable (bolt-on) equipment mounting rails.

B. The top of the rack shall be pre-punched with attachment holes for cable runway and a top-mount cable management jumper tray. The sides of the rack shall be pre-punched with attachment points for power strips, snap-on cable guides and vertical cable managers. The bottom of the rack shall be pre-punched with attachment points for a junction box and attachment to the floor.

C. Equipment mounting rails shall be L-shaped, set 6” (150 mm) or 3” (80 mm) apart and punched on the front flange with the EIA-310-D Universal hole pattern to provide 44 rack-mount spaces for equipment. Each mounting space shall be marked and numbered on the mounting rails. Mounting rails shall be removable and reversible so that RMU numbering can start at the bottom or top of the rack.

D. Equipment-mounting rails shall be horizontally spaced to allow attachment of 19” EIA rack-mount equipment. Attachment points shall be threaded with 12-24 threads.

E. The rack shall have two masked ground connection points located near the top and bottom of the frame and will include a ground terminal lug to attach ground conductors from the Telecommunications Grounding Busbar. Equipment mounting rails will bond to the rack through assembly hardware.

F. The rack shall measure 7’ (2.1 m) high, 24” (610 mm) wide and 15” (380 mm) deep at the base. The sides of the rack frame shall be 9.6” (294 mm) deep.

G. The rack shall be rated for 1,000 lb (453.6 kg) of equipment in seismic areas and meet Telecordia Technologies GR-63-CORE Network Equipment Building Systems (NEBS) Zone 4 requirements.

H. Finish shall be epoxy-polyester hybrid powder coat in the color as specified below. Mounting rails will be painted to match or zinc-plated.

I. 4-post racks shall be designated for equipment only.

2.02 DESIGN MAKE:

A. Chatsworth Products, Inc. (CPI),

B. Standard Two-Post Rack
   1. Part Number 55053-703, Standard Rack, 7’H (2.1 m) x 20.3”W (515.9 mm) x 15”D (381.0 mm), 45U x 19”EIA, Black, UL Listed.
   2. Part Number 40605-001, Equipment Mounting Screws, #12-24, 50 pack, Zinc
   3. Part Number 40605-005, Equipment Mounting Screws, #12-24, 50 pack, Black
   4. Part Number 12637-001, Cage Nuts and Mounting Screws, M6, 25 pack, Gold
   5. Part Number 12638-001, Cage Nuts and Mounting Screws, #10-32, 25 pack, Zinc
   6. Part Number 12639-001, Cage Nuts and Mounting Screws, #12-24, 25 pack, Black
C. QuadraRack™ 4-Post Frame
   1. Part Number 55053-703, QuadraRack™ 4-Post Frame, 19” x 7’, Black.

2.03 CABLE MANAGEMENT

A. Each rack shall have a minimum of two double-sided vertical cable manager attached to the each side of the rack. The cable manager will have separate front-facing and rear-facing C-shaped troughs to hold cables. The troughs will attach to the rack with slotted brackets that allow the troughs to be adjusted in depth and positioned to align with the front and rear of the rack. When positioned to align with the front and rear of the rack, there will be a space between the troughs along the side of the rack. Each trough will have large, plastic edge-protected openings along the sides to allow cables to enter/exit the trough and connect to equipment on the front/rear of the rack. Plastic spin-open latches at the front of each trough will secure cables in the trough. Large, edge-protected, rectangular openings at the rear of the trough will allow cables to exit the rear of the trough. The rear of the troughs will also be punched with keyhole slots to support power strips in the space in between the front and rear trough. Each cable management trough shall measure 7’ (2.1 m) high, 6” (150 mm) wide and 6.3” (162 mm) deep at the base. Two troughs are included with each vertical cable manager.

B. Snap-on plastic cable guides with T-shaped dividers and openings that align with each RMU space on the rack shall be attached to the front side of each rack next to the vertical cable managers to provide by-RMU cable management for cables entering/exiting the rack.

C. Materials: Provide cabinets and enclosures as follows:
   1. Provide electrical cabinets and enclosures which are UL listed and labeled, and constructed in conformance with UL 50 "Cabinets and Boxes."
   2. In normally dry interior locations, provide sheet steel with corrosion resistant fasteners.
   3. Outdoors and in damp interior locations, provide galvanized sheet steel with stainless steel fasteners.
   4. At constantly wet locations or corrosive atmospheres, provide stainless sheet steel with stainless steel fasteners

D. Rail Mounts: Full enclosure length rack angles shall be installed and have ANSI/EIA RS-310-C mounting standards with 10-32 tapped mounting holes in each enclosure

E. Shelf: Provide a shelf or other suitable mounting plate for all non rack mountable equipment

F. Painting: In addition to galvanizing or priming coat, all inside and outside surfaces of trim and doors shall be given a factory finish coat of paint.

G. Grounding:
   1. Comply with Section 280526.
   2. Provide cabinets and enclosures with provision for cabinet grounding without penetrating exterior wall of the enclosure.

2.04 SLIDE OUT RACKS

A. Provide slide out 19” racks to provide rear access to wiring and components. Custom build unistrut support to accommodate slide out rack. Provide the following or approved equal from other manufacturers.
1. Middle Atlantic Products: SRS Series

B. Provide key-locking latches for doors.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

A. Mounting: Mount cabinets at a uniform height, nominally 6 feet to the top of the enclosure above finished floor, except as otherwise noted or physically not practical. Mount cabinets with fronts straight and plumb.

B. Bracing: Brace or anchor all free-standing/wall-mounted cabinets using Uni-strut or other approved method to building structure.

C. Flush Cabinets: Set flush cabinets in finished spaces flush with adjacent walls. Mount cabinets with fronts straight and plumb.

D. Painting: Touch up all welds, scrapes and other mars in the enclosure finish with a rust inhibiting paint.

E. Front Access: Locate with minimum of 36 inches clear space in front of each cabinet or rack.

F. Other Access: Provide minimum 36 inches clear space to each side of enclosure which requires access for inspection or service.

**END OF SECTION 27 11 16**
SECTION 27 11 23

LADDER RACKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install a complete cable ladder system as shown on the drawings. Cable ladder will be used for cable management inside the TC closets.

B. Cable ladder systems are defined to include, but are not limited to straight sections of Ladder, type cable ladders, bends, tees, elbows, drop-outs, supports and accessories.

C. Cable Runway will only be placed in Telecom and Server rooms below the ceiling. Cable Runway will not be placed above ceilings to convey cables throughout the building.

1.02 REFERENCES


B. ASTM B633 - Specification for Electro-deposited Coatings of Zinc on Iron and Steel

C. NEMA VE 1 - Metallic Cable ladder Systems.

1.03 DRAWINGS

A. The drawings which constitute a part of these specifications indicate the general route of the cable ladder systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc., is directed.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.04 SUBMITTALS

A. Submittal Drawings: Submit drawings of cable ladder and accessories including clamps, brackets, hanger rods, splice plate connectors, expansion joint assemblies, and fittings, showing accurately scaled components.

B. Product Data: Submit manufacturer's data on cable ladder including, but not limited to, types, materials, finishes, rung spacing, inside depths and fitting radii. For side rails and rungs, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of cable ladders and fittings of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

LADDER RACKING
27 11 23 - 1
B. NEMA Compliance: Comply with NEMA Standards Publication Number VE1, "Cable ladder Systems".

C. NEC Compliance: Comply with NEC, as applicable to construction and installation of cable ladder and cable channel systems (Article 318, NEC).

D. UL Compliance: Provide products which are UL-classified and labeled.

E. NFPA Compliance: Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable ladder systems.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver cable ladder systems and components carefully to avoid breakage, denting and scoring finishes. Do not install damaged equipment.

B. Store cable ladders and accessories in original cartons and in clean dry space; protect from weather and construction traffic.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with these specifications, cable ladder and cable channel systems to be installed shall be as manufactured by Chatsworth, Inc. or engineer approved equal.

2.02 CABLE LADDER SECTIONS AND COMPONENTS

A. General: Except as otherwise indicated, provide metal cable ladders, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

1. Materials and Finish: Material and finish specifications for each cable ladder type are as follows:

2. 1.5" Tubular Steel: Straight section and fitting side rails and rungs shall be extruded from ASTM A513 steel tube. All fabricated parts shall be finished with a black powder coat.

2.03 TYPE OF CABLE LADDER SYSTEM

A. Ladder type cable ladders shall consist of two longitudinal members (stringers) with transverse members (rungs) welded to the stringers. Rungs shall be spaced 9" inches on center. Rung spacing in radius fittings shall be 9 inches and measured at the center of the cable ladder's width.

Rungs shall have a minimum cable bearing surface of 1" with radius edges. No portion of the rungs shall protrude below the bottom plane of the side rails.

B. Straight cable ladder sections shall have side rails fabricated as tubular steel channels. All straight sections shall be supplied in standard 10 foot lengths, except where shorter lengths are permitted to facilitate cable ladder assembly lengths as shown on drawings.

C. Cable ladder widths shall be 12", 18" or 24" inches as indicated on drawings.

D. Splice plates shall be the bolted type made as indicated below for each cable ladder type. The resistance of fixed splice connections between an adjacent section of cable ladder shall not exceed .00033 ohm. Splice plate
construction shall be such that a splice may be located anywhere within the support span without diminishing the cable ladder rated loading capacity.

E. All splice materials shall be made of ASTM A570 structural steel using carriage bolts and serrated flange locknuts. Hardware shall be Yellow Zinc Dichromate. Chatsworth # 16299-001 or approved equal.

F. Cable ladder Supports: Shall be placed so that the support spans do not exceed a maximum span of 5’ feet. Supports shall be constructed from formed shape channel members 1 5/8” x 1 5/8” with necessary hardware such as trapeze support kits, ceiling support kits, triangular support brackets, or wall angle support kits as manufactured by Chatsworth Products or engineer approved equal.

G. Trapeze hangers shall be supported by 3/8” (minimum) diameter all thread rods.

H. Accessories - special accessories shall be furnished as required to protect, support, and install a cable ladder system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially-designed ladder drop-outs, barriers, etc.

2.04 LOADING CAPACITIES

A. Cable ladders shall meet NEMA class designations: 8A.

PART 3 EXECUTION

3.01 INSTALLATION

A. All cable ladder will be installed in the IC and/or TC spaces only. Cable ladder is not acceptable in the space above the ceiling for distribution of horizontal cable runs. Refer to Cable Tray section 270528.

B. Install cable ladders as indicated; in accordance with equipment manufacturer’s instructions, and with recognized industry practices, to ensure that cable ladder equipment comply with requirements of NEC, and applicable portions of NFPA 70b and NECA’s "Standards of Installation" pertaining to general electrical installation practices.

C. Coordinate cable ladder with other electrical work as necessary to properly interface installation of cable ladder work with other work.

D. Provide sufficient space encompassing cable ladders to permit access for installing and maintaining cables.

E. Ground all cable ladder to the communications room bus bar. Use ground straps between each section of runway installed or where splice plates are used to join sections. Scrape paint away from cable runway at points of connection to each section of runway by the ground strap.

3.02 TESTING

A. Test cable ladders to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. Refer to NFPA70B, Chapter 18, for testing and test methods.

END OF SECTION 27 11 23
PART 1 - GENERAL

1.01 SCOPE

A. Work included: All labor, materials, appliances tools, equipment, facilities transportation, and services necessary for and incidental to performing all operations in connection with furnishing, delivery, and installation of the work of this Section. Complete as specified herein. Work includes, but is not necessarily limited to, the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

B. Conduit system, outlets, and related equipment shall be furnished and installed complete by the same contractor. All wiring shall be installed in a conduit system. The system shall be installed by the manufacturer's authorized installer. The entire system operation, function, testing, and maintenance for one year after final acceptance by the District, shall be the responsibility of the Contractor.

C. The Contractor shall furnish and install all equipment, cables, devices, and other materials even though not specifically mentioned herein, which are necessary for the proper integration of the system, so that the system shall perform the function listed herein compliance with all the specified requirements.

1.02 SUBMITTAL

A. Provide a current letter of recommendation from the manufacturer, addressed to District. The contractor must be certified with the manufacturer for at least twelve (12) months prior to letter of recommendation. The letter of recommendation must be given to General Contractor at time of bid.

B. Provide certification of the certified installer for this project at time of bid.

C. Provide installer’s experience and qualifications, which shall include three (3) years of projects of similar complexity. Include names and locations of two projects successfully completed using an instructional classroom technology.

D. Provide documentation stating you have been in the telecommunication contracting business for a minimum of five (5) years under the same name and are located within a four (4) hour response time of the District.

E. Complete bill of materials, including all quantities of components, devices, equipment, and wiring, required shall be submitted to complete this project.

F. Complete bill of materials, including all quantities of components, devices, equipment, and wiring, required shall be submitted to complete this project.
G. Manufacturer’s specification sheets, model numbers of equipment, and descriptions of component operation shall be submitted.

1.03 EQUIPMENT QUALIFICATION

A. The specification is based on the equipment of manufacturers who have been approved by the District, and the manufacturers herein named shall be considered as meeting the requirements of this specification. For all items which are identified by part number and manufacturer, the performance specifications, which are published in the most recent manufacturer’s data sheets, available at the time of bidding this project shall be applicable to the present work as though fully written out herein.

B. All equipment shall conform to all federal, state, and local applicable codes and ordinances, and shall be listed by Underwriter Laboratories.

C. Comply with NFPA 70

D. Comply with UL 50

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Acceptable Manufacturers:
   1. Williams Sound, Eden Prairie, MN.

2.02 PRODUCTS

A. Transmitters:
   1. PPA T45NET
   2. PPA T46
   3. PPA T27

B. Receivers:
   1. PPA R38
   2. PPA R37

C. Accessories:
   1. Earphones
      a. EAR 008
      b. EAR 013
      c. EAR 014
      d. EAR 022
      e. EAR 042
   2. Headphones
      a. HED 021
      b. HED 026
      c. HED 027
      d. HED 040
   3. Neckloops
      a. NKL 001
   4. Batteries
      a. BAT 001-2
      b. BAT 026-2
   5. Carry Cases
      a. CCS 029
      b. CCS 030 35
   6. Rack Mount Kits
      a. RPK 005
2.03 COMPONENT PERFORMANCE CRITERIA

A. Stationary Transmitter (PPA T45NET):
1. Dimensions: 8.45” W x 8.25” D x 1.72”H (21.5 cm x 21 cm x 4.4 cm)
2. Mounting: One EIA rack space high; ½ rack space chassis wide.
3. Power Input: 100-240 VAC, 60 Hz.
4. Power Output: 24 VAC, 750 mA, 18W.
5. Operating Temperature: +32° F to +104° F (0° C to 40° C)
6. Operating Frequencies: 72.1 - 75.9 MHz, 17 wide band channels (selectable)
7. Frequency Accuracy: ±2 ppm stability, 0-50? C.
8. Deviation: +/- 75 kHz maximum.
9. Pre-Emphasis: 75 µsec
10. RF Field Strength: Max 80 mV/m at 3 m.
11. Nominal Range: Up to 1000 feet (using ANT 005 coaxial antenna).
13. Signal to Noise Ratio: ≥74 dB Transmitted RF
14. Total Harmonic Distortion: Less than 0.25% @ 1 kHz (RF output)
15. Common Mode Rejection: >57 dB @ 1 kHz, Mic or Line
16. Audio Inputs: (1x) Combination 3-pin XLR, 1/4” TRS jack for Mic or Line Level Analog Audio. Balanced or Unbalanced Line Level, or Microphone with Selectable Phantom Power; (1x) XLR for Digital Audio, AES3/EBU, supported sample rates 44.1 kHz and 48 kHz; (1x) RCA for Digital Audio, S/PDIF, supported sample rates 44.1 kHz and 48 kHz.
17. Audio Input Gain Adjust: In menu, adjustable to 0 to -50 dB, in 1dB steps
18. Phantom power: 14.4 VDC applied through 2.2 kΩ resistors to analog combo jack: Pin 2 and Pin 3 on XLR jack, or tip and ring on 1/4” TRS jack.
19. Audio Level Indicators: 10-LED array that reads -18 to +9 dB at 3 dB intervals. 7 Green, 2 Amber, and 1 red LED. Green LEDs indicate normal operating audio level peaks, Amber LEDs indicate close to overload peaks, Red LED indicates overload peaks.
21. Headphone Output: 1/4” TRS stereo jack, mono signal, 15.7 mW, maximum in 33 Ω (level adjustable in menu 0 to -40 dB in 2 dB steps)
22. Line Output: RCA jack (black), -10 dBV (.32 VRMS). Output impedance 100 Ω.
23. Ethernet: RJ-45 on back of unit
25. Warranty: Lifetime PLUS Limited Warranty
26. Total Harmonic Distortion: Less than 0.25% @

B. Portable Transmitter (PPA T46): [select as needed]
1. Dimensions: 4.1” L x 2.8” W x 1.1” D (104 mm x 71 mm x 28 mm)
2. Weight: 2.6 oz (74 g), no batteries
3. Color: Black/Silver
4. Enclosure Material: Shatter-resistant PC/ABS plastic with textured scratch-resistant aluminum faceplate
5. Battery Type options: Two (2) AA 1.5 V non-rechargeable Alkaline batteries (BAT 001-2), 75 mA nominal current drain, up to 30 hours battery life, or two (2) AA 1.5 V NiMH rechargeable batteries (BAT 026-2), 75 mA nominal current drain, up to 20 hours battery life per charge, recharges in 14-16 hours, uses CHG 3502 or CHG 3512 Charger

6. Operating Frequencies: Selectable, 17 channels, 72.1 - 75.9 MHz*. Switchable 8 or 17 Channel Mode. (8-channel mode setting allows only the 8 non-interfering simultaneous-use channels to be selected)

7. Stability: ± .005%, frequency synthesized, crystal reference, PLL

8. Modulation: Wide-band FM, 75 kHz peak, 75 µS pre-emphasis

9. RF Output: Max 80 mV/m at 3m

10. Freq Response: 180 Hz - 13 kHz, ±3 dB at 1% max. THD

11. SNR: 65 dB (typical) transmitted

12. Transmit Antenna: Integral with mic cord

13. Microphone: Electret type, 3.5 mm mono plug

14. Display: OLED for status and menu info
   a. Status: Ch/Freq, Mic Audio Level, Auxiliary Input Audio Level, Battery Status, Mic Mute, Channel Lock, Dual-Preset mode.
   b. Menu: Ch/Freq display mode select, Volume, Aux Input, Compression,
   c. 17 or 8-channel mode, screen time out, screen brightness, restore default settings

15. External Controls: Momentary push button: push and hold 3 seconds for power On/Off, push and release for microphone mute On/Off.
   a. Left, Right and Menu buttons for accessing and changing transmitter settings. Battery type switch (Alkaline or NiMH) located behind the battery compartment door.

16. External Indicators: Power LED - Green, flashes when battery is low
   a. 17. Mic Input: 3.5 mm mono jack with electret mic bias, adjustable gain with 25 dB range
   b. 18. Aux Input: 2.5 mm stereo jack, adjustable gain with 60 dB range
   c. 19. Audio Compression: 1:1 (off) or 2:1 (on) selectable in menu

C. Stationary Transmitter (PPA T27): [select as needed]
1. Dimensions: 4.1” W x 6.1” L x 1.3” H (104.1 mm x 154.9 mm x 33 mm)
2. Weight: 7.8 oz. (221 g)
3. Color: Black

4. Power (U.S./Canada): 105-130 VAC, 50-60 Hz, 3.2 W at 120 VAC

5. Operating Frequencies: 72-76 MHz*: 72.1 (CH A), 72.2 (CH K), 72.3 (CH B), 72.4 (CH N), 72.5 (CH C), 72.6 (CH O), 72.7 (CH D), 72.8 (CH P), 72.9 (CH E), 74.7 (CH I), 75.3 (CH J), 75.4 (CH R), 75.5 (CH F), 75.6 (CH S), 75.7 (CH G), 75.8 (CH T), 75.9 (CH H)

6. Frequency Selector: External switches, 17 channels (lockable)

7. RF Field Strength: Does not exceed 80mV/m @ 3m

8. Nominal Range: Up to 1000 feet (305 m) w/standard ANT 021 “rubber duckie” antenna or optional ANT 005 coaxial antenna.


10. Stability: ± .005% over 0-50°C

11. Pre-Emphasis: 75 µS

12. Frequency Response: 85Hz - 14kHz ±3dB

13. Distortion: 1% Max. THD


15. Microphone Input: 3.5mm mini phone jack, supplies +DC for electret mics
16. Mic Input Level: 1-10 mV, nominal
18. Line Input Level: 0.1-1.0 Vrms, nominal
19. Input Attenuator: Pot, screwdriver-adjustable
20. Antenna Outputs: Thread mount for ANT 021 “rubber duckie” antenna or ANT 025 telescoping antenna RF connector for ANT 024 dipole or ANT 005 coaxial antenna
21. Approvals: FCC, IC, RoHS, WEEE
22. Warranty: Lifetime PLUS Limited Warranty

D. Receiver (PPA R38): [select as needed]
1. Dimensions: 4.1” x 2.85” x 1.38” (104 x 72 x 35mm)
2. Weight: 4.6oz (130g) with batteries; 2.6oz (73g) without batteries
4. Battery Type: (2) AA Alkaline or (2) AA NiMH Rechargeable
5. Battery Life: (2) AA non-rechargeable alkaline batteries (BAT 001-2), approx. 50 hrs. (2) AA rechargeable NiMH batteries (BAT 026-2), 1500mAh, approx. 32 hrs.
6. Current Consumption: 52mA nominal
7. Operating Temp. Range: 32° - 122°F (0° to 50°C)
8. Channels: 17 Wideband, accessed via menu
9. Operating Frequencies:
   a. 72.1, 72.2, 72.3, 72.4, 72.5, 72.6, 72.7, 72.8, 72.9, 74.7, 75.3, 75.4, 75.5, 75.6, 75.7, 75.8, 75.9 MHz*
10. FM Deviation: 75 kHz
11. De-Emphasis: 75 µS
12. Display Screen: 1" OLED
15. Sensitivity: 2 µV at 12 dB Sinad with squelch defeated
16. Input Overload: 100 mV
17. Freq Response 200 Hz - 15 kHz, ±3dB
18. Modulation: FM, +/- 75 kHz peak deviation
19. Signal-to-Noise Ratio: Min 65 dB @ 1.0V
20. Receive Antenna: Integral with earphone/headphone cord
21. Audio Output: 35 mW max at 16 Ω
22. Headphone Connector: 3.5 mm stereo jack, mono output for stereo or mono earphones or headphones
23. Supplied Earphone: Stereo, earbud-type with foam cushion, 3.5 mm plug, 32 Ω
24. Power Save Mode: Enters sleep mode after approximately 3 minutes of no RF signal
25. Approvals: FCC, IC, RoHS, WEEE
26. Warranty: Lifetime PLUS Limited Warranty

E. Receiver (PPA R37): [select as needed]
1. Dimensions: 4.1” x 2.85” x 1.38” (104 x 72 x 35mm)
2. Weight: 4.6oz (130g) with batteries; 2.6oz (73g) without batteries
3. Color: Black
4. Battery Type: (2) AA Alkaline or 2 x AA NiMH
5. Battery Life: Two (2) AA non-rechargeable alkaline batteries (BAT 001), approx. 50 hrs; or (2) AA rechargeable NiMH batteries (BAT 026), 1500 mAh, approx. 32 hrs
6. Current Consumption: 52mA nominal
7. Temperature Range: - 0 to 50°C
8. Channels: 17, accessed via seek button in battery compartment
<table>
<thead>
<tr>
<th>9. Operating Freq.:</th>
<th>72.1, 72.2, 72.3, 72.4, 72.5, 72.6, 72.7, 72.8, 72.9, 74.7, 75.3, 75.4, 75.5, 75.6, 75.7, 75.8, 75.9 MHz*</th>
</tr>
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<tbody>
<tr>
<td>10. Intermediate Freq.:</td>
<td>75 kHz</td>
</tr>
<tr>
<td>11. FM Deviation:</td>
<td>75 kHz</td>
</tr>
<tr>
<td>12. De-Emphasis:</td>
<td>75 µS</td>
</tr>
<tr>
<td>13. LED Indicator:</td>
<td>Power: Green; Low Battery: Flashes Green</td>
</tr>
<tr>
<td>14. AFC Range:</td>
<td>± 120 kHz</td>
</tr>
<tr>
<td>15. Sensitivity:</td>
<td>2 µV at 12 dB Sinad with squelch defeated</td>
</tr>
<tr>
<td>16. Input Overload:</td>
<td>100 mV</td>
</tr>
<tr>
<td>17. Frequency Response:</td>
<td>200 - 15 kHz</td>
</tr>
<tr>
<td>18. Modulation:</td>
<td>FM, +/- 75 kHz peak deviation</td>
</tr>
<tr>
<td>19. Signal-to-Noise Ratio:</td>
<td>65 dB min @ 100 uV</td>
</tr>
<tr>
<td>20. Receive Antenna:</td>
<td>Integral with earphone/headphone cord</td>
</tr>
<tr>
<td>21. Audio Output:</td>
<td>35 mW peak into 16 Ω</td>
</tr>
<tr>
<td>22. Output Connector:</td>
<td>3.5 mm stereo/mono jack</td>
</tr>
<tr>
<td>23. Earphone:</td>
<td>Earbud-type with foam cushion, 3.5 mm plug, 32 Ω</td>
</tr>
<tr>
<td>24. Auto Shut-off:</td>
<td>Enters sleep mode after approx 6 mins of no RF signal</td>
</tr>
<tr>
<td>25. Approvals:</td>
<td>FCC, IC, RoHS, WEEE</td>
</tr>
<tr>
<td>26. Warranty:</td>
<td>Lifetime PLUS Limited Warranty</td>
</tr>
</tbody>
</table>

F. Accessories:
1. Earphones
2. [Wide Range Earphone: Model EAR 008]
3. [Single Mini Earbud: Model EAR 013]
4. [Dual Mini Earbud: Model EAR 014]
5. [Surround Earphone: Model EAR 022]
6. [Dual, in-ear, isolation: Model EAR 042]

G. 2. Headphones
1. [Deluxe Folding: Model HED 021]
2. [Rear-wear, Mono: Model HED 026]
3. [Heavy-duty, Folding, Mono: Model HED 027]
4. [Protector, Dual-Earmuff: Model HED 040]

H. 3. Neckloop
1. [18in cord, 3.5mm plug): Model NKL 001]

I. 4. Batteries
1. [AA Alkaline: Model BAT 001-2]
2. [AA NiMH: Model BAT 026-2]

J. 5. Carry Cases
1. [Small Briefcase for accessories: CCS 029]
2. [Large 35-slot Case: Model CCS 030 35]

K. 6. Rack Mounts
1. [Single Rack Mount Kit for Half Rack Space Products: Model RPK 005]
2. [Dual Rack Mount Kit for Half Rack Space Products: Model RPK 006]

L. 7. Antennas
1. [Remote Coaxial Antenna for 72-76 MHz PPA Transmitters: Model ANT 005]

M. 8. Chargers
1. [12 Units, R37 or R38: Model CHG 3512]
PART 3 - EXECUTION

3.01 INSTALLATION

A. The installation shall be accomplished by and under the direction of skilled electronic craftsmen, factory trained by the equipment manufacturer, and experienced in the installation of systems of this type in the State of California. Workmanship shall be of the highest quality.

B. Note that the general installation requirements of Division 26 0000 apply to work performed under this Section.

C. All wiring shall be neat and orderly. Disorganized "rats nests" of wire and cable will not be allowed. Terminal punch blocks and patch panels should be used for all system wire connections wherever possible, and all connections must be accessible. Absolutely no connections are to be made in wet locations or below grade.

D. The conduit, outlet boxes, terminal cabinets, etc., which form a part of the rough-in work shall be furnished and installed complete as described and otherwise required in other sections of this Division 26 0000.

E. The balance of the system, including installation of the communication equipment, making all connections, etc., shall be performed by the manufacturer’s authorized representative, and the entire responsibility for the proper operation, function, testing and complete maintenance for two (2) years after final acceptance by the District, shall be the responsibility of this sub-contractor.

F. During preparation for installation of any of the systems described in this Section of these Specifications and prior to ordering any material, coordinate all options and requirements with the District.

G. Provide and install all cables as required specifically for each installation as needed for a complete and operable installation.

3.02 TESTS, INSTRUCTION AND DOCUMENTATION

A. The entire system shall be tested and adjusted under the supervision of the Contractor’s electronics engineer.

1. Provide all instruments for testing and demonstrate in the presence of the District’s Representative that all telephone circuits and wiring are free of shorts and grounds and that the installation performs as required and is as specified herein.

2. Program all control functions as needed. Coordinate all optional features of all systems with the District.

3. Any defects or abnormalities shall be corrected at once and the test re-conducted to demonstrate proper operation.

4. A complete report of all these tests shall be prepared by the testing personnel and signed by them. The report shall include the date the testing was conducted a narrative describing each test and the results of all testing upon correction of all defects. The site inspector shall be informed of the testing schedule and his signature shall appear on the report attesting to the fact that these tests were conducted. The original copy of the final signed report shall be submitted to the Architect; and following his review, copies of the report shall be included in the operations and maintenance manuals provided to the District.
B. The equipment supplier/installer shall instruct the District or his designated representative(s) in the proper operation and maintenance of the system. Allow a minimum of four (4) hours for this on-site "hands-on" instruction. The Electronics Contractor shall provide sufficient personnel to provide adequate operations and maintenance training for all aspects of the system to the school staff.

1. Approximately 30 days after final acceptance of the system, or as requested by the District, a follow up training session shall be scheduled at the site. Any special operating problems shall be resolved and the system shall be fully checked out and "fine tuned" as required. Allow a minimum of four (4) hours on site for the instruction portion of this requirement.

C. Three complete sets of maintenance instructions, system/component data sheets and operating instructions shall be bound into three ring binders permanently labeled "Telephone Systems" and delivered to the Architect.

1. Preface the Telephone Systems manuals with a typewritten sheet in a plastic protector identifying the system installer by business name, address and telephone number.

2. The manuals shall include all approved submittal information, product data sheets, spare parts list, trouble shooting guides, complete "as-built" and one line diagrams, as necessary for the proper operation and servicing of the system. Provide an index to all material and indexing dividers for easy location of information.

D. In addition to the three Maintenance and operations manuals described above, the following shall be provided:

1. One manufacturer's operators manual for each telephone set provided plus five spares of each type.

2. A one or two page (8-1/2"x 11") "Users Manual" suitable for photocopying and distribution to the teaching staff. This manual shall concisely describe the system features available (from the classroom) and provide specific operating instructions for utilizing these features. Cooperate with school administration in development of this reproducible "User's Manual".

E. All original equipment documentation and manuals provided by the equipment manufacturers shall be safeguarded and turned over to the District at the completion of the project.

END OF SECTION 27 51 26
SECTION 28 13 00

ACCESS CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Access control system requirements.
B. Access control units and software.
C. Access control point peripherals, including readers.
D. Accessories.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 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 the contract documents. Obtain direction before proceeding with work.

B. 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.

1.04 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 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 detailed field testing procedures.

J. Field quality control test reports.

K. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

L. 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.

M. Warranty: Submit sample of manufacturer’s warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

N. 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.

### 1.05 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70.
   3. The requirements of the local authorities having jurisdiction.
   4. 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.
E. Maintenance Contractor Qualifications: Same entity as installer.

1.06 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.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 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

2.01 MANUFACTURERS

A. Access Control System - Basis of Design: Software House CCure 9000.

B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

2.02 ACMAMS CONTOLLERS

A. General

1. An intelligent controller with integrated battery backup, database, and communication ports that supports 16 card readers.

2. Supports multiple communication channels to which a variety of devices can connect.

3. Supports hardware modules used for additional memory and/or for future feature enhancements.

4. Functions provided:
   a. Central control for attached devices and addressable modules
   b. Makes decisions for access
   c. Responds to monitor activity
   d. Receives input to control decision making
   e. Reports activity to other devices

B. Features

1. Supports HID Proximity MIFARE, and DESFire card reader formats

2. Supports flash upgrades for firmware updates

3. Utilizes an onboard Ethernet NIC for TCP/IP communication, supporting IPv4 and IPv6

4. Global input/output and anti-passback functionality

5. Capable of utilizing keypad commands to activate/deactivate events

C. Supports RS-485 or RS-422 connectivity to addressable modules:

1. Input Module: Supports 8 Class A supervised input points

2. Output Module: Supports 8 Form C dry contact relays
3. Reader Interface Module Supports 2 or 4 card readers with associated
   alarm contacts, request-to-exit devices, and lock outputs

D. Manufacturer
   1. Software House #iSTAR Pro 64MB control panel
      a. Accessories
         1) Software House #I8 input module
         2) Software House #R8 output module
         3) Software House #RM-4E

2.03 EQUIPMENT ENCLOSURES

A. General
   1. Provide enclosures with butt hinged and lockable door containing a lock
      kit (keyed alike with other security enclosures on the project)
   2. Provide perforated back panel for mounting control boards, relays, and
      terminal strips with enclosure
   3. Provide slotted wiring duct for routing security cabling within enclosure
   4. One tamper switch for each enclosure

B. Security Equipment Cabinets
   1. Type: NEMA ty1 enclosure
   2. Size: 36” x 24” x 6” minimum
   3. Finish: ANSI 61 gray polyester powder paint finish inside and out
   4. Manufacturer:
      a. Cooper B-Line #36246-IPP with back panel and lock kit
      b. Hoffman # A36N24M with #36N24MPP back panel and #A612AR lock kit
      c. Or equal

C. Security Junction Boxes
   1. Type: NEMA ty1 enclosure
   2. Size: 12” x 12” x 6” minimum
   3. Finish: ANSI 61 gray polyester powder paint finish inside and out
   4. Manufacturer:
      a. Cooper B-Line #12126-IPP with back panel and lock kit
      b. Hoffman # A12N126 with #12N12PP back panel and #A612AR lock kit
      c. Or equal

D. Slotted Wiring
   1. Type: Lead-free PVC with narrow finger design
   2. Size: 1” x 1” minimum
   3. Color: Light gray
   4. Manufacturer:
      a. Panduit # Type-F narrow slot wiring duct
      b. Iboco #T1-1010 wiring duct
      c. Or equal

2.04 WIREWAYS

A. General:
   1. Provide screw cover wireway sections with open top assembly as
      shown on Security drawings
   2. Provide closure plates to secure end of wireway sections

B. Screw Cover Gutter Wireways
   1. Type: NEMA type 1 enclosure
   2. Size: 4”x4”x4” minimum
3. Finish: ANSI 61 gray polyester powder paint finish inside and out
4. Manufacturer:
   a. Cooper B-Line #4448-G-NK lay-in painted wireway without knockouts
   b. Hoffman #F44T148GVP lay-in painted wireway without knockouts
   c. Ore equal
5. Accessories
   a. Cooper B-Line #44-E-NK closure plate without knockouts
   b. Hoffman #A44GCPNK closure plate without knockouts
   c. Or equal

2.05 TERMINAL BLOCKS

A. General
   1. Provide terminal blocks inside SEC for demarcation of elevator traveler and security cabling
   2. Provide DIN rails and other mounting accessories for a complete installation

B. Modular Terminal Strips
   1. Push-in style bridging system that utilizes the IDC termination method
   2. Feed through style, single level
   3. Modular design
   4. Capable of mounting on standard 35mm DIN rails
   5. Manufacturer
      a. Phoenix Contact #QTC-1.5 terminal block
      b. Weidmuller
      c. Or equal
   6. Accessories
      a. Phoenix Contact #NS-35/7,5 DIN rail
      b. Weidmuller
      c. Or equal

2.06 CARD READERS

A. General
   1. Presenting an access card to the reader initiates a single transmission to the ACAMS controller
   2. Rugged, weatherized polycarbonate enclosure, designed to withstand an operating temperatures of -22 to 120 degrees Fahrenheit (-30 to 65 degrees Celsius) and operating humidity of 5-95% non-condensing
   3. Utilizes a Wiegand protocol for communication for compatibility with standard access control systems
   4. Utilizes a multi-color LED and an audible sounder to indicate the status of the door.
   5. Utilizes an internal tamper switch that will indicate an alarm condition if an unauthorized attempt is made to disassemble the unit
   6. FCC and CE certified, and confirm to the following ISO standards:
      a. 15693 (CSN read-only)
      b. 14443A (CSN read-only)
      c. 14443B (CSN read-only)
   7. Capable of reading the following frequencies and card formats:
      a. 125kHz - HID, Indala, or AWID proximity
      b. 13.56MHz - MyD, ISO 15693 CSN, ISO 14443A CSN, ISO 14443B CSN, and US Government PIV

B. Manufacturer
   1. HID # multiCLASS series
a. Wall mount: HID #RP40 multi-technology card reader
b. Wall mount with keypad: HID #RPK40 multi-technology card reader with integrated keypad
c. Mullion style #RP15 multi-technology card reader

2.07 ACCESS CARDS

A. General
   1. Provide iCLASS cards
   2. Utilizes a graphics quality surface that supports direct-to-card printing

B. Manufacturer
   1. HID #2002 iCLASS smart card

2.08 MAGNETIC CONTACT SWITCHES

A. Wood, Steel, and Hollow Metal Doors
   1. General
      a. Mounting: Recessed
      b. Contacts: Single Pole, Single Throw
      c. Gap Distance: 0.5" maximum
   2. Manufacturer
      a. GE security #1078C 3/4" alarm contact switch
      b. GRI
      c. Or equal

B. Local Audible Alarmed Doors
   1. General
      a. Mounting: Recessed
      b. Contacts: Single Pole, Single Double Throw
      c. Gap Distance: 0.5" maximum
   2. Manufacturer
      a. GE Security #1076C 3/4" alarm contact switch
      b. GRI
      c. Or equal

C. Overhead Roll-Up Doors
   1. General
      a. Mounting: Surface
      b. Contacts: Single Pole, Single Throw
      c. Gap distance: 3.0" maximum
      d. Wiring: Armor Cable, 12" minimum
   2. Manufacturer
      a. GE Security #2205 floor mounted contact switch with 3' armored cable lead
      b. GRI
      c. Or equal

2.09 REQUEST TO EXIT MOTION SENSORS

A. General
   1. Power: 12 or 24VDC, 35mA
   2. Relay Output: 2 form "C" contacts
   3. Adjustable relay latch time
   4. Programmable retrigger or non-retrigger mode
   5. Programmable Fail Safe or Fail Secure Modes
   6. Radio Frequency Interference (RFI) Immunity range from 26 to 1,000MHz at 50 v/m

B. Manufacturer
1. Bosch #DS160 with TP160 trim plate
2. Honeywell #IS320WH with IS310WHTP trim plate
3. Or equal

2.10 LOCAL AUDIBLE ALARMS

A.  
1. Panel operating voltage selectable 12 or 24VDC at 150mA
2. Keyswitch operation using rim cylinder provided by Owner to match existing standard
3. Utilizes 80Db horn
4. Input points for door switch, alarm shunt, door status, tamper switch, and key switch override
5. Output points for door propped alarm, intrusion alarm, door status, tamper switch, and key switch override
6. Timers for access period, warning period, and auto reset
7. Tamper switch to detect the removal of the unit from the electrical back box

B. Manufacturer
1. Designed Security #4200 local alarm sounder
2. Or equal

2.11 ACAMS POWER SUPPLIES

A. General
1. Provides a 120VAC to 12 and 24VDC output, fully supervised power supply to power ACAMS field devices
2. Utilizes 16 fused Class 2 rated power limited outputs
3. Short circuit and thermal overload protection
4. Integrated charger for sealed lead acid or gel type batteries
5. Capable of providing a 10 amp supply current
6. Supports a fire alarm disconnect to relay that individually selects any or all of the 16 outputs
7. Enclosure with integrated tamper switch

B. Manufacturer
1. Altronix #MAXIM75 power supply
2. Or equal

2.12 BATTERIES

A. General
1. Voltage: 12.00
2. Amps: 12.00
3. Chemistry: SLA or VRLA valve regulated
4. Termination: Spade protected terminals

B. Manufacturer
1. Yuasa #RE12-12 sealed lead acid 12V 12Ah battery
2. Interstate Batteries #SLA1105 sealed lead acid 12V 12Ah battery
3. Or equal

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

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.

3.02 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 34.
   6. Conceal all 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.

3.03 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.

3.04 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 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.

3.06 PROTECTION
A. Protect installed system components from subsequent construction operations.

3.07 MAINTENANCE
A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
B. 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.
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 13 00
PART 1  GENERAL

1.01  SECTION INCLUDES
A. Video surveillance system requirements.
B. Video recording and viewing equipment.
C. Cameras.
D. Accessories.

1.02  REFERENCE STANDARDS
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03  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 the 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.

1.04  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:
   1. Standby battery/UPS calculations.
   2. Video storage capacity calculations.

E. Certify that proposed system design and components meet or exceed specified requirements.

F. Evidence of qualifications for installer.

G. Manufacturer’s detailed field testing procedures.

H. Field quality control test reports.

I. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

1.05 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.

1.06 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.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 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

2.01 MANUFACTURERS

A. Video Surveillance System _________.
   1. Network Video Recorder Software - Other Acceptable Manufacturers
      a. Salent Systems

B. Cameras - Basis of Design: _________.
   1. IP Cameras - Other Acceptable Manufacturers:
      a. Sony
      b. AXIS Communications
      c. Arecont Vision
      d. Or equal
2.02 CAMERA SYSTEM

A. General
1. Type: Color, solid-state CCD with DSP technology, unless otherwise noted
2. Power: 24 VAC/VDC
3. Imager: 1/3 inch format, unless otherwise noted
4. Lens Mount: Accept a "CS" mount auto or manual-iris lens
5. Synch: adjustable line lock for synchronizing camera to power lin. No auxiliary sync cable required.
6. Resolution: 640x480 minimum resolution, unless otherwise noted
7. Minimum Light Level: 0.1 fc imager illumination at full video, unless otherwise noted
8. Lens: Field determine, unless otherwise noted

B. Fixed IP Interior Dome Cameras
1. Complete repackaged unit containing:
   a. Minimum 1280x720 megapixel resolution for fixed cameras, with progressive scan
   b. Resolution: 30 frames per second at all resolutions
   c. Video streaming: Simultaneous Motion JPEG and H.264
   d. Auto Iris, verifocal lens of 2.5-6mm
   e. Security: IP address filtering and HTTPS encryption
   f. Power over Ethernet
   g. Connectors: Ethernet 10/100 BaseT, RJ-45
   h. Dome housing
2. Manufacturer:
   a. AXIS #P3344 network dome megapixel camera
   b. Sony #SNCDH140 network dome megapixel camera
   c. Arecont Vision #AV1355 network dome megapixel camera
   d. Or Equal
3. Accessories
   a. AXIS In-Ceiling Mount #5502-361 or Surface Mounting Plate #5502-401
   b. Sony In-Ceiling Mount #YTICB45
   c. Arecont Vision Surface Mounting Plate #MD-EBA
   d. Or Equal

C. Exterior Fixed IP Mini-Dome Cameras
1. Complete prepackaged unit containing:
   a. Superior 1.3 megapixel image sensor quality with progressive scan
   b. Resolution: 12 frames per second at 1280x1024 and 30 frames per second at 640x480
   c. Video streaming: Simultaneous Motion JPEG and MPEG-4
   d. Auto iris, varifocal lens of 2.8-10mm
   e. Security: IP address filtering and HTTPS encryption
   f. Power over Ethernet (IEEE 802.3af), Class 1
   g. Connectors:
      1) Ethernet 10/100 BaseT, RJ-45
      2) Terminal block for alarm inputs, output, and RS-485/422
      3) Analog video, BNC composite output
      4) Audio line output, mini-jack
   h. Vandal resistant dome housing
i. Manufacturer:
   1) Axis #P3344-VE megapixel network mini-dome camera
   2) Or Equal
j. Accessories:
   1) Axis #5502-321 Pendant kit
   2) Axis #5017-611 Wall Bracket
   3) Axis #5017-641 Corner Bracket
   k. Axis #5017-671 Pole Bracket

D. PTZ IP Dome Camera
   1. Provide IP PTZ camera with appropriate mount to flush mount into roof soffit
   2. Complete prepackaged unit containing:
      a. 1/4” high-resolution color CCD camera & motorized zoom auto-iris lens
      b. Resolution: Supports 1280x720 resolution at 30 frames per second
      c. Resolution: 30 frames per second at all resolutions
      d. High-speed pan and tilt that is stepper motor driven (belt-driven not acceptable).
      e. Integral receiver/driver
      f. Color
      g. Integral 18X min optical zoom lens for exterior locations
      h. Exterior cameras: wide dynamic range and auto day/night switching between color and B/W
      i. Motion JPEG and H.264 video compression
      j. Integrated heater and blower for exterior locations
      k. Power over Ethernet plus (IEEE 802.3at) compatible
      l. Electronic Image Stabilizer
   3. Provide seismic support of unit attached directly to roof soffit structure.
   4. Manufacturer:
      a. Sony #SNCRH164
      b. AXIS #P5534 Series
      c. Or Equal
   5. Accessories:
      a. Sony #UNI#MB1 mounting bracket
      b. AXIS #T91A Mounting Accessories
      c. Or Equal

2.03 NETWORK VIDEO RECORDERS

A. Features
   1. Complete Network Video Recorder platform that encompasses recording, viewing, reviewing recorded video, and storing video for indefinite periods of time.
   2. Full control of camera selections, sequencing, and viewing modes
   3. The system simultaneously records, displays live video, and plays back video. None of the video operations interfere with each other. Live view and video playback does not interrupt the recording process.
   4. Recorders store digital IP video. Recorders may record full-time, in response to an alarm, or based on a user-defined schedule. Full-time recording refers to 24 hours per day, 7 days per week, 365 days per year.
   5. Video Capture: Captures camera signals from fixed IP cameras, IP PTZ cameras, and IP video encoders.

B. Recorders
   1. Use TCP/IP network protocol to communicate with network cameras and other video encoders
   2. Video Information
a. Store the time, date, and source of the video and be available during playback.
b. Store for each clip video source, capture date, start time, and stop time. Source identified as either a monitor or a camera.
c. Store alarm information in the database on the main server when the video is in response to an alarm condition.

3. Recording Configuration
   a. Use TCP/IP network protocol to communicate to head end.
   b. Captures camera signals from fixed cameras, PTZ cameras, infrared cameras, x-ray cameras, and low light cameras. Camera signals may be color, black and white, or both.
   c. Capable of simultaneously recording each camera at VGA (640x480) and 1.3 megapixel (1280x800) resolutions at 30 frames per second.

4. Video Storage
   a. Video stored in clips on the recorder's internal hard drive. As the hard drive becomes full, groom oldest clips to make room for new video.
   b. Ability to utilize a variety of network storage devices such as external disk arrays, RAID and NAS devices, and external disk drives for exporting, backup, or sharing images.
   c. Ability to modify video quality per camera with respect to recorder and server configurations, length of time video to be store.
   d. Ability to burn DVD's of selected video segments at user's discretion.

5. Video Authentication
   a. Fingerprint each video clip through a mathematical algorithm during the video capture process. The fingerprint becomes part of the clip and used by the playback software to verify the video has not been altered.

6. Alarm recording
   a. Recording Options
      1) Alarm condition via activation of an external alarm contact.
      2) Internal video motion detection
      3) Alarm condition via software integration with ACAMS
   b. Recording programmable by camera and by time and date schedule.
   c. Allow a mix and match of continuous recording and alarm recording, based on camera input and capture card connection.
   d. Pre and post alarm recording

7. Video Motion Detection
   a. Support cameras capable of detecting activity from camera input and to initiate an alarm condition.
   b. Video motion detection areas operator selectable for each camera. If the scene changes within the alarm area, an alarm condition is initiated.

8. Viewing of both live and archived images, from multiple remote systems.

9. Remote event notification

10. Password protected via user authorization, with profiles assigned by the system administrator, and database tracking of events.

C. NVR Hardware
    1. Server hardware typically furnished by Owner's IT department

D. NVR Video Management Software
1. Video surveillance software must have software integration with ACAMS. Hard-wired input/output alarms is not acceptable.
2. Include software licenses:
   a. Camera licenses to support devices shown on project drawings
   b. Client workstation licenses to support a minimum of 5 concurrent users
   c. Internet Explorer client browser license
3. Manufacturer:
   a. Salient Systems Complete View Enterprise

### 2.04 POWER SUPPLIES/BATTERY CHARGERS

A. CCTV System Power Supplies
   1. 120 VAC input to 24 VAC output, continuous current, fully supervised power supplies for power to cameras.
   2. Provide a separate fused connection to power supply per camera.
   3. Exterior PTZ Camera
      a. Pelco #WCS 1-4 NEMA4X/IP66 rated for outdoor use
      b. AXIS #5000-001 24VAC Outdoor power supply
      c. Altronix
      d. Or Equal

### 2.05 CCTV LIGHTNING PROTECTORS

A. Power Line Protectors
   1. Provide on power lines serving exterior cameras.
   2. Manufacturer:
      a. PolyPhaser Corp #IS-SPTV
      b. DITEK
      c. Or Equal

B. PTZ Data Line Protectors
   1. Provide on data lines serving exterior IP cameras.
   2. Manufacturer:
      a. PolyPhaser Corp #NX4-60-IG
      b. DITEK
      c. Or Equal

### 2.06 IP VIDEO ENCODER

A. General
   1. Video Compression: Motion JPEG, MPEG-4 Part 2 (ISO/IEC 14496-3), Profiles: ASP and SP
   2. Resolution: 4CIF, 2CIFExp, 2CIF, QCI
   3. Frame Rate: Up to 30/25 per channel
   4. Pan/Tilt/Zoom control
   5. Alarm and event management
   6. Channels: 4 minimum

B. Blade Video Server
   1. Hot-swappable
   2. Built-in, universal power supply
   3. Security: IP address filtering and HTTPS encryption
   4. Manufacturer:
      a. Axis #243Q blade video server
      b. Or equal

C. Video Server Rack Enclosure
   1. High density rack-mount solution
2. Capable of storing a minimum of 3 interchangeable and hot-swappable blade video servers
3. Manufacturer
   a. Axis #291 1U video server rack
   b. Or equal

EXECUTION

3.01 INSTALLATION

A. CCTV Cameras
   1. Provide outdoor housing and mounts for exterior cameras.
   2. Field determine exact placement of cameras to ensure complete coverage.
   3. Coordinate location with obstructions such as columns or exceedingly high shelving units to avoid concealment opportunity.
   4. Field determine fixed camera lens size to ensure complete coverage.
   5. Route watertight flex from junction box to camera housing from below on exterior cameras.
   6. Provide 25 foot cable loop at PTZ location for relocating unit if required post installation
   7. Coordinate Network Data Drop with Telecom contractor for each IP Camera.
   8. Coordinate camera IP address with District IT staff.

B. CCTV Power supplies
   1. Do not combine with Access Control & Alarm Monitoring System power supplies.

C. Network Video Recorder Storage
   1. Coordinate installation of additional camera licenses and programming of cameras on existing network video server with District ITS

D. Surge Protection
   1. Provide surge protection for video, power, and control cable on exterior cameras.
   2. Provide protective device at the camera and encoder/recorder device

3.02 PROGRAMMING

A. Coordinate a meeting with Owner’s IT representative to determine IP addresses and LAN/WAN utilization of IP cameras and NVRs.

B.
   1. Camera naming
   2. PTZ Presets
   3. Schedules and recording parameters including quality and frame rate (including video motion detection)
   4. ACAMS alarm and event integration requirements for workstation pop-ups and recording.
   5. Video archiving schedule
   6. Live viewing requirements
   7. System data base backups

C. Document the results of the meeting and perform necessary programming to achieve the Owner’s requests.

D. Setup and program the system such that no additional programming required.
E. Use the camera naming convention agreed upon at in the programming meeting when programming point names into the system.

F. Perform a full system back-ups at completion of initial programming and deliver one copy to the Owner with a Letter of Transmittal explaining information included in back-up and brief description of recovery procedures.

G. Customize menus with the assistance of the factory to "gray-out" features not used on project (such as elevator control).

H. Perform field software changes after the initial programming session to "fine tune" operating parameters and sequence of operations based on revised operating requirements.

3.03 TESTING

A. Commission the video surveillance system in accordance with Section 280800.

3.04

END OF SECTION 28 23 00
SECTION 28 31 00

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire alarm system design and installation, including all components, wiring, and conduit.
B. Transmitters for communication with supervising station.
C. Circuits from protected premises to supervising station, including conduit.

1.02 REFERENCE STANDARDS

C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 WARRANTY

A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
   1. Provide all components necessary, regardless of whether shown in the contract documents or not.
   2. Protected Premises: Entire building shown on drawings.
   3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
      a. ADA Standards.
      b. The requirements of the State Fire Marshal.
      c. The requirements of the local authority having jurisdiction, which is Campus Fire Department and County Fire Authority.
      d. Applicable local codes.
      e. The contract documents (drawings and specifications).
f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.

4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.


6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.

7. Program notification zones and voice messages as directed by Owner.

8. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.


10. Master Control Unit (Panel): New, located at supervising station.

B. Supervising Stations and Fire Department Connections:

1. Public Fire Department Notification: By on-premises supervising station.

2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at Administration Building.

3. Means of Transmission to On-Premises Supervising Station: Directly connected noncoded system.

C. Circuits:

1. Initiating Device Circuits (IDC): Class B, Style A.

2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.

3. Notification Appliance Circuits (NAC): Class B, Style W.

D. Spare Capacity:

1. Initiating Device Circuits: Minimum 25 percent spare capacity.


4. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:

1. Primary: Dedicated branch circuits of the facility power distribution system.

2. Secondary: Storage batteries.

3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.


2.02 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 and as shown on drawings.

1. Sprinkler water control valves.

2. Elevator shut-down control circuits.

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:

1. Sprinkler water flow.

2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
4. Duct smoke detectors.
5. Heat detectors.

C. Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.

D. HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.

E. Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 71 00.

2.03 COMPONENTS

A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Control Unit: As specified for Basis of Design above, or equivalent.

D. Initiating Devices

E. Notification Appliances

F. Circuit Conductors: Copper or optical fiber; provide 200 feet (60 m) extra; color code and label.

G. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

H. Locks and Keys: Deliver keys to Owner.
1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type.

I. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
2. Provide one for each control unit where operations are to be performed.
3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
4. Provide extra copy with operation and maintenance data submittal.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
C. Obtain Owner's approval of locations of devices, before installation.
D. Install instruction cards and labels.

3.02 INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.
B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
E. Provide all tools, software, and supplies required to accomplish inspection and testing.
F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
H. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without any system or equipment malfunctions.
   1. Record all system operations and malfunctions.
   2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
   3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
   4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:
   2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
   3. Factory Instruction: At control unit manufacturer's training facility.
B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
   1. Initial Training: 1 session pre-closeout.
C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
   1. Initial Training: 1 session pre-closeout.

D. Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
   1. Initial Training: one week, pre-closeout.

E. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

### 3.04 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
   1. Be prepared to conduct any of the required tests.
   2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
   3. Have authorized technical representative of control unit manufacturer present during demonstration.
   4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
   5. Repeat demonstration until successful.

B. Occupancy of the project will not occur prior to Substantial Completion.

C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
   1. Specified diagnostic period without malfunction has been completed.
   2. Approved operating and maintenance data has been delivered.
   3. All aspects of operation have been demonstrated to Owner.
   4. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
   5. Specified pre-closeout instruction is complete.

### 3.05 MAINTENANCE

A. Provide to Owner, a proposal as an alternate to the base bid, for a maintenance contract for entire warranty period, to include the work described below; include the total cost of contract, proposal to be valid at least until 30 days after date of Substantial Completion.

B. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
   1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
   2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
   3. Record keeping required by NFPA 72 and authorities having jurisdiction.

C. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 2 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.

D. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

E. Maintain a log at each fire alarm control unit, 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. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

F. Comply with Owner's requirements for access to facility and security.

END OF SECTION 28 31 00
SECTION 31 10 00

SITE CLEARING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Clearing and protection of vegetation.
B. Removal of existing debris.

1.02  RELATED REQUIREMENTS

A. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
B. Section 01 57 13 - Temporary Erosion and Sediment Control.
C. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
D. Section 02 41 00 - Demolition: Removal of built elements and utilities.
E. Section 31 23 23 - Fill: Filling holes, pits, and excavations generated as a result of removal operations.
F. Section 32 93 00 - Plants: Relocation of existing trees, shrubs, and other plants.

PART 2  PRODUCTS

2.01  MATERIALS

A. Fill Material: As specified in Section 31 23 23 - Fill and Backfill

PART 3  EXECUTION

3.01  SITE CLEARING

A. Comply with other requirements specified in Section 01 70 00.
B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02  EXISTING UTILITIES AND BUILT ELEMENTS

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
B. Protect existing utilities to remain from damage.
C. Do not disrupt public utilities without permit from authority having jurisdiction.
D. Protect existing structures and other elements that are not to be removed.

3.03  VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
B. Do not begin clearing until vegetation to be relocated has been removed.
C. Preservation of existing vegetation: The construction schedule shall consider the amount and duration of soil exposed to erosion by wind, rainfall, and vehicle tracking and seek to minimize disturbed soil during the rainy season. A schedule shall be prepared that shows the sequencing of construction activities with installation of maintenance of soil stabilization and sediment control BMPs.

D. Do not remove or damage vegetation beyond the limits indicated on drawings.
1. Exception: Specific trees and vegetation indicated on drawings to be removed.
2. Exception: Selective thinning of undergrowth specified elsewhere.

E. Install substantial, highly visible fences at least 4 feet high to prevent inadvertent damage to vegetation to remain:
1. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
2. Around other vegetation to remain within vegetation removal limits.
3. See Section 01 5000 for fence construction requirements.

F. Around other vegetation to remain within vegetation removal limits.

G. See Section 01 50 00 for fence construction requirements.

H. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

I. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 36 inches.
3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 36 inches.
4. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

J. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

K. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.04 DEBRIS

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 31 10 00
SECTION 31 22 00

GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of topsoil.
B. Rough grading the site for site structures, building pads, and paved areas.
C. Finish grading.

1.02 RELATED REQUIREMENTS

B. Section 31 10 00 - Site Clearing.
C. Section 31 23 16 - Excavation.
D. Section 31 23 16.13 - Trenching: Trenching and backfilling for utilities.
E. Section 31 23 23 - Fill: Filling and compaction.

1.03 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with the Standards Specifications for Public Works Construction (Greenbook); latest edition.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: See Section 31 23 23.
B. Other Fill Materials: See Section 31 23 23.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey monuments and intended elevations for the Work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.
B. Stake and flag locations of known utilities.
C. Protect from damage above- and below-grade utilities to remain.
D. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

E. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.

F. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.03 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
   1. Remove sod, grass, and any other vegetation before stripping top soil.
   2. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
   3. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.
   4. Strip topsoil to depth indicated on drawings.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. See Section 31 23 23 for filling procedures.

G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.

H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 SOIL REMOVAL

A. Stockpile topsoil to be re-used on site; remove remainder from site.
   1. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water and other erosion control measures.
      a. Limit height of topsoil stockpiles to 72 inches.
      b. Do not stockpile topsoil within plant protection zones.
      c. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or resued.

B. Stockpile subsoil to be re-used on site; remove remainder from site.

3.05 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.
B. Remove debris, roots, branches, stones, in excess of 2 inch (50 mm) in size. Remove soil contaminated with petroleum products.

C. Scarify site in accordance with the Geotechnical requirements and as indicated on the plans.

D. Place topsoil in areas indicated.

E. Place topsoil during dry weather.

F. Remove roots, weeds, rocks, and foreign material while spreading.

G. Near plants spread topsoil manually to prevent damage.

H. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

I. Lightly compact placed topsoil.

3.06 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) (30 mm) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch) (13 mm).

3.07 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from a certified Arborist as to remedy.

C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.08 FIELD QUALITY CONTROL

A. See Section 31 23 23 for compaction density testing.

3.09 CLEANING

A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 31 22 00
GRADING
31 22 00 - 4
SECTION 31 23 16

EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for footings, slabs-on-grade, paving, and site structures.
B. Trenching for utilities outside the building to the point of connection to public and/or private utility mains.

1.02 RELATED REQUIREMENTS

A. Document Geotechnical Investigation Report for Proposed Physical Education and Student Union Complex (L-636), Los Medanos Community College, RMA Group no. 15-095-02 dated January 6, 2016: Geotechnical report; boring hole locations and findings of subsurface materials.
B. Section 01 57 13 - Temporary Erosion and Sedimentation Control: Slope protection and erosion control.
C. Section 31 22 00 - Grading
D. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.
E. Section 31 23 23 - Fill: Fill materials, filling, and compacting.

1.03 PROJECT CONDITIONS

A. Verify that survey monuments and intended elevations for the Work are as indicated.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.
B. Locate, identify, and protect utilities that remain and protect from damage.
C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
D. Protect plants, lawns, rock outcroppings, and other features to remain.

3.03 EXCAVATING

A. Excavate to accommodate new structures and construction operations.
B. Notify the Owner's representative of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
C. Slope banks of excavations deeper than 4 feet (1.2 meters) to angle of repose or less until shored.

D. Do not interfere with 45 degree bearing splay of foundations.

E. Cut utility trenches wide enough to allow inspection of installed utilities.

F. Hand trim excavations. Remove loose matter.

G. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.

H. Grade top perimeter of excavation to prevent surface water from draining into excavation.

I. Remove excavated material that is unsuitable for re-use from site.

J. If excavated material is to be re-used as fill, stockpiling of soil must be in an area designated for stockpiling on site in accordance with Section 31 22 00.

K. Remove excess excavated material from site.

### 3.04 FIELD QUALITY CONTROL

A. See Section 01 4010 - DSA Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

### 3.05 PROTECTION

A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

END OF SECTION 31 23 16
TRENCHING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Excavating, backfilling and compacting for utilities outside the building to point of connection with public and/or private utility mains.

1.02  RELATED REQUIREMENTS

A. Document Geotechnical Investigation Report for Proposed Physical Education and Student Union Complex (L-636), Los Medanos Community College, RMA Group no. 15-095-02 dated January 6, 2016: Geotechnical report; bore hole locations and findings of subsurface materials.

B. Section 31 22 00 - Grading: Site grading.

C. Section 31 23 16 - Excavation: Building and foundation excavating.

D. Section 31 23 23 - Fill: Backfilling at building and foundations.

1.03  REFERENCES


B. Standard Specifications, California State Department of Transportation (Caltrans), latest edition.


E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN/m³)); 2012.


G. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.


I. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

J. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

L. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2010.

1.04 SUBMITTALS

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

B. Samples: 10 lb (4.5 kg) sample of each type of fill; submit in air-tight containers to testing laboratory.

C. Materials Sources: Submit name of imported materials source.

D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

E. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where allowed by the Owner's representative.
   1. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. General Fill: Stripped topsoil or expansive soil with clay usable in landscape or non-structural area.
   1. Free of lumps larger than 3 inches, rocks larger than 2 inches, debris, and large organic material.

B. Engineered Fill: Structural fill conforming to the requirements of the Geotechnical Report and in accordance with specification section 312 323 Fill.

C. Aggregate Base: 3/4" Class 2 conforming to Caltrans Section 26 with a minimum R-value of 78.
   1. Acceptable as Engineered Fill.

D. Concrete for Backfill of Utility Trenches: Controlled Low-Strength Material, CLSM, per Caltrans Section 19-3.02G for bedding of storm drainage or sanitary sewer pipes, 100 psi compressive strength, minimum.

E. Course Aggregate: Crushed rock, 1/2" maximum, conforming to the Greenbook Section 200-1.2.

F. Granular Fill - Pea Gravel: Natural stone; washed, free of clay, shale, organic matter.
   1. Graded in accordance with ASTM C136/C136M, within the following limits:
      a. Minimum Size: 1/4 inch (6 mm).
      b. Maximum Size: 5/8 inch (16 mm).

G. Sand: Conforming to Greenbook Section 200-1.5.

2.02 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable, woven, Mirafi; 140N manufactured by Mirafi.
2.03 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, testing of samples for compliance will be provided before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey monuments and intended elevations for the work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect utilities that remain and protect from damage.

C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

D. Protect plants, lawns, rock outcroppings, and other features to remain.

E. Protect existing trees and tree roots. Trenching under the dripline of existing trees shall be performed by hand using hand tools.

3.03 TRENCHING

A. Notify the Owner's Representative of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Slope banks of excavations deeper than 4 feet (1.2 meters) to angle of repose or less until shored.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Cut trenches wide enough to allow inspection of installed utilities.

E. Hand trim excavations. Remove loose matter.

F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

G. Remove excavated material that is unsuitable for re-use from site.

H. Stockpile excavated material to be re-used in area designated in Section 31 22 00.

I. Remove excess excavated material from site.

J. Trenching under the dripline of existing trees shall be performed by hand using hand tools only. Contractor shall not cut or damage existing roots unless approved by a certified Arborist.

3.04 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.05 BACKFILLING

A. Backfill to elevations indicated using unfrozen materials.
B. Fill up to subgrade elevations unless otherwise indicated.
C. Employ a placement method that does not disturb or damage other work.
D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
E. Maintain optimum moisture content of fill materials to attain required compaction density.
F. Correct areas that are over-excavated.
   1. Thrust bearing surfaces: Fill with concrete.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.
G. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: 90 to 95 percent of maximum dry density as indicated in the Geotechnical Report.
   2. At Landscaped areas: 90 percent of maximum dry density.
H. Reshape and re-compact fills subjected to vehicular traffic.

3.06 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Use Engineered Fill compacted to 90 percent of maximum dry density where trenches cross under footings, grade beams, and other structural elements. Otherwise, use General Fill unless otherwise specified or indicated.
B. Utility Piping, conduits, and duct banks:
   2. Cover with general fill. See subsection 'A' above.
   3. Fill up to subgrade elevation.
   4. Compact in maximum 6 inch (150 mm) lifts to 90 percent of maximum dry density.
C. Over Subdrainage Piping at Foundation Perimeter and Under Slabs:
   1. Drainage fill and geotextile fabric: Section 33 46 00.
   2. Cover drainage fill with general fill. See subsection 'A' above.
   3. Fill up to subgrade elevation.
   4. Compact to 90 percent of maximum dry density.

3.07 TOLERANCES

A. Top Surface of General Backfilling: Plus or minus 1 inch (25 mm) from required elevations.
B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch (25 mm) from required elevations.
3.08 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.

C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180, or ASTM D698 ("standard Proctor").

D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

E. Frequency of Tests: As required by the Geotechnical Engineer.

3.09 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 31 23 16.13
SECTION 31 23 23

FILL

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Filling, backfilling, and compacting for footings, slabs-on-grade, paving, and site structures.
B. Backfilling and compacting for utilities outside the building to utility main connections.
C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.02  RELATED REQUIREMENTS

A. Document Geotechnical Investigation Report for Proposed Physical Education and Student Union Complex (L-636), Los Medanos Community College, RMA Group no. 15-095-02 dated January 6, 2016: Geotechnical report; bore hole locations and findings of subsurface materials.
B. Section 01 57 13 - Temporary Erosion and Sediment Control: Slope protection and erosion control.
C. Section 03 30 00 - Cast-in-Place Concrete.
D. Section 31 22 00 - Grading: Site grading.
E. Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.
F. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

1.03  DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.
B. Subgrade Elevations: Indicated on drawings.

1.04  REFERENCE STANDARDS

B. Standard Specifications, California State Department of Transportation (Caltrans), latest edition.
E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
G. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.

1.05 SUBMITTALS

A. See Section 01 3300 - Administrative Requirements, for submittal procedures.

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.

D. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. When fill materials need to be stored on site, locate stockpiles where designated.
   1. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. General Fill: Stripped topsoil or expansive soil with clay usable in landscape or non-structural area.
   1. Free of lumps larger than 3 inches, rocks larger than 2 inches, debris, and large organic material.

B. Engineered Fill: Structural fill conforming to the requirements of the Geotechnical Report, and as indicated on the plans.
   1. Non-expansive (no clay), well-graded, slightly cohesive, fine silty sand or sandy silt loam material without organics, debris, fragments, or rocks larger than 2 inches, and no more than 3% organics.
   2. Percent passing No. 200 sieve: 20% to 50%.
   3. Plasticity Index (PI): 10 maximum.
   4. Expansion Index: 15 maximum.
   5. Clean sand or very sandy soil is not acceptable.

C. Aggregate Base: 3/4" Class 2 conforming to Caltrans Section 26 with a minimum R-value of 78.
   1. Acceptable as Engineered Fill.

D. Concrete for Backfill of Structures: Slurry cement per Caltrans Section 19-3.02E, 1000 psi compressive strength, minimum.
   1. Acceptable as Engineered Fill.

E. Concrete for Backfill of Utility Trenches: Controlled Low-Strength Material, CLSM, per Caltrans Section 19-3.02G for bedding of storm drainage or sanitary sewer pipes, 100 psi compressive strength, minimum.

F. Course Aggregate: Crushed rock, 1/2" maximum, conforming to the Greenbook Section 200-1.2.

G. Granular Fill - Pea Gravel: Natural stone; washed, free of clay, shale, organic matter.
   1. Graded in accordance with ASTM C136/C136M, within the following limits:
      a. Minimum Size: 1/4 inch (6 mm).
      b. Maximum Size: 5/8 inch (16 mm).
H. Sand: Conforming to the Greenbook, Section 200-1.5.

2.02 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable, woven, Mirafi; 140N manufactured by Mirafi.
B. Vapor Retarder: 10 mil (0.25 mm) thick, polyethylene.

2.03 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
B. Where fill materials are specified by reference to a specific standard, testing of samples for compliance will be provided before delivery to site.
C. If tests indicate materials do not meet specified requirements, change material and retest.
D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey monuments and intended elevations for the Work are as indicated.
B. Identify required lines, levels, contours, and datum locations.
C. See Section 31 22 00 for additional requirements.
D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.
E. Verify structural ability of unsupported walls to support imposed loads by the fill.

3.02 PREPARATION

A. Scarify and proof roll subgrade surface to a depth as required per the Geotechnical Report and in accordance with the plans.
B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

A. Fill to elevations indicated using unfrozen materials.
B. Fill up to subgrade elevations unless otherwise indicated.
C. Employ a placement method that does not disturb or damage other work.
D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
E. Maintain optimum moisture content of fill materials to attain required compaction density.
F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm)6 inches (150 mm) compacted depth.

G. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

H. Correct areas that are over-excavated.
   1. Load-bearing foundation surfaces: Use engineered fill, flush to required elevation, compacted to 90 percent of maximum dry density.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 90 percent of maximum dry density.

I. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: 90 to 95 percent of maximum dry density as required in the plans.
   2. At Landscape areas: 90 percent of maximum dry density.

J. Reshape and re-compact fills subjected to vehicular traffic.

3.04 TOLERANCES
   A. Top Surface of General Filling: Plus or minus 1 inch (25 mm) from required elevations.
   B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch (25 mm) from required elevations.

3.05 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
   B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 1557 ("modified Proctor").
   C. If tests indicate work does not meet specified requirements, remove work, replace and retest.
   D. Frequency of Tests: as required by Geotechnical Engineer.
   E. Proof roll compacted fill at surfaces that will be under slabs-on-grade.

3.06 CLEANING
   A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
   B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
   C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 31 23 23
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Excavating, treatment, and placement of lime treated subsoil mix to be used as E

1.02 RELATED REQUIREMENTS
   A. Section 31 23 16 - Excavation: General site and building excavation.
   B. Section 31 23 16.13 - Trenching: Backfilling of utility trenches.
   C. Section 31 23 23 - Fill: Soil and aggregate materials.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. Submit mix design and materials mix ratio that will achieve specified requirements.

1.05 FIELD CONDITIONS
   A. Do not install mixed materials in wind in excess of 10 mph (16 k/h) or when temperature is below 40 degrees F (5 degrees C).

PART 2 PRODUCTS

2.01 MIX MATERIALS
   A. Coarse Aggregate: Granular fill specified in Section 31 23 23.
   C. Lime: AASHTO M 216 hydrated lime.

2.02 EQUIPMENT
   A. Equipment: Capable of excavating subsoil, mixing and placing materials, wetting, consolidation, and compaction of material.

2.03 LIME/SOIL MIX
   A. A specialty Contractor shall be consulted to select the lime content and mixing procedure to reduce the plasticity index (PI) of the treated soil to 15 or less.

PART 3 EXECUTION

3.01 GENERAL
   A. Lime treatment of soils is not preferred or currently allowed for this project unless proposed/ submitted by the Contractor, and reviewed/ approved by the District's Geotechnical Engineer.
3.02 PREPARATION

A. On-site materials containing roots or other organic matter are not suitable for lime treatment and shall be stripped from the area(s) where lime treatment is to be performed.

B. Do not place fill over frozen or spongy subgrade surfaces.

3.03 SOIL TREATMENT

A. Material shall be mixed with lime to a depth of 18 inches to reduce the expansion potential.

B. The lime or selected stabilizing agent may be spread in dry form or as slurry.

C. Dry lime shall be spread and mixed in a fashion that reduces potential for dusting.

D. Casting or tailgating of dry lime is not recommended. The spreading and mixing procedure shall produce a consistent distribution of stabilizing agent in the treated soil.

E. Mixing and pulverizing shall continue until the treated soil does not contain untreated soil clods larger than 1 inch and the quantity of untreated soil clods retained on the No. 4 sieve is less than 40 percent of the dry soil mass.

F. The lime-treated fill shall be compacted to 90 percent relative compaction (expressed as percent relative compaction or ratio of field density to reference density, as evaluated by ASTM D1557).

G. Lime-treated soils are not allowed in planting/planter areas.

3.04 FIELD QUALITY CONTROL

A. Periodic testing shall be performed by the Contractor (unless otherwise undertaken by the Owner's representative) to evaluate the plasticity index of the treated soil.

END OF SECTION 31 32 13.19
PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Furnish all labor, material, equipment and services required to maintain landscape in a healthy growing condition and in a neat and attractive appearance throughout the maintenance period.

1.02 RELATED REQUIREMENTS

A. Division 32 Section Landscape Irrigation
B. Division 32 Section Landscape Work

1.03 QUALITY ASSURANCE

A. The Maintenance Contractor shall be experienced in horticulture and landscape maintenance, practices and techniques, and shall provide sufficient number of workers with adequate equipment to perform the work during the maintenance period.

1.04 MAINTENANCE PERIOD

A. Continuously maintain the entire project area during the progress of the work and during the ninety (90) calendar-day maintenance period until final acceptance of the project by the Landscape Architect.
   1. Maintenance Period begins following "Final Completion" of the Project and after all punchlist or corrective items have been accepted by the Landscape Architect and owner.
B. Maintenance period shall not start until final completion, when all elements of construction, planting and irrigation for the entire project are in accordance with Plans and Specifications. A prime requirement is that all lawn and landscape areas shall be planted and that all lawn areas shall show an even, healthy stand of grass seedlings which shall have been mown twice. If such criteria are met to the satisfaction of the Landscape Architect, a written notification shall be issued to establish the effective beginning date of maintenance period.
C. Any day of improper maintenance, as determined by the Landscape Architect, shall not be credited as an acceptable maintenance period day. The maintenance period shall be extended on a daily basis if the work is not in accordance to the Plans and Specifications. Project shall not be segmented into maintenance areas or phases, unless authorization of the Landscape Architect is obtained.
D. Maintenance shall continue beyond the ninety (90) day maintenance period, as required, until final acceptance is given by the Landscape Architect.
E. Contractor shall provide protection to the project site during the maintenance period.
F. A phased maintenance period will not be accepted.
1.05 GUARANTEE AND REPLACEMENT

A. Guarantee: All plant material and other materials installed under the Contract shall be guaranteed against any and all poor, inadequate or inferior materials and/or workmanship or improper maintenance, as determined by the Landscape Architect, and shall be replaced by the Contractor at his expense. Warranty periods are as follows:
   1. Trees, vines, and shrubs: One Year
   2. Groundcover and Turf: One year.

B. Replacement: Any materials found to be dead, missing, declining or not in a satisfactory or healthy condition during the maintenance period shall be replaced immediately. The Landscape Architect shall be sole judge as to the condition of material. Material to be replaced within the guarantee period shall be replaced by the Contractor within five (5) days of written notification by the Landscape Architect or owner. All replacement materials and installations shall comply with the Plans and Specifications. Any plant missing due to suspected theft shall be replaced by the Contractor. If the Contractor suspects that theft may be a problem, the Contractor shall provide written documentation to the owner that security on this site needs to be intensified.

C. The Contractor may relieve himself of theft responsibility if after the security notice, with no result, a written notice to the owner shall be given that plant material will not be replaced for theft or vandalism due to lack of site security being maintained. This procedure may take place only during the Landscape Maintenance Period.

1.06 OBSERVATION SCHEDULE

A. Normal progress observations shall be requested by the Contractor from the Landscape Architect as per observations listed in specifications Division 32 Section "Landscape Work."

1.07 FINAL ACCEPTANCE OF THE PROJECT

A. Upon completion of all project work, including maintenance period, the Landscape Architect will, upon proper written request, make an observation to determine final project acceptability. Provide minimum a 14 business day notice for final observation.

B. Where observed work does not comply with the Plans and Specifications, replace rejected work and continue specified maintenance period until reinspected by the Landscape Architect and determined to be acceptable. All replacement materials and installations shall be in accordance with the Plans and Specifications. Remove rejected work and materials immediately from project. Prior to the date of final observation, Contractor shall provide the Landscape Architect with all Record Drawings and close out documents in accordance with the Plans and Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials used shall either conform to Specifications in other sections or shall otherwise be acceptable to the Landscape Architect. The Landscape Architect shall be given a monthly record of all herbicides, insecticides and disease control chemicals used and irrigation scheduled. The amendments listed herein are for Bidding purposes only. The final amendment types and rates shall be determined by the Agronomic Soils Test.
B. Turf maintenance fertilizer: shall be "Best Turf Supreme 16-6-8":
   1. 6% nitrogen
   2. 6% phosphoric acid
   3. 8% potash

C. Slow Release maintenance fertilizer: shall be "Best Superturf 25-5-5 with Polyon" and shall consist of the following percents by weight:
   1. 25% nitrogen
   2. 5% phosphoric acid
   3. 5% potash

PART 3 - EXECUTION

3.01 GENERAL MAINTENANCE

A. General: Proper maintenance, including watering, weeding, mowing, edging, fertilization, rolling of turf, replacement and infill of mulch, replacement of jute mesh, infill of settled areas, repairing and protection shall be required until entire project is finally accepted, but in any event for a period of not less than the specified maintenance period after planting.

B. Watering: Thoroughly water to insure vigorous and healthy growth until work is accepted. Water in a manner to prevent erosion due to application of excessive quantities of water. When hand watering use a water wand to break the water force. Supplemental hand water as required to maintain and encourage the proper growth of new and existing plant material.

C. Weeding:
   1. Keep plant basins, turf areas and areas between plants free of weeds. Control weeds with pre-emergent herbicides. If weeds develop, use legally approved herbicides and hand remove. Avoid frequent soil cultivation that destroys shallow roots. Weeding also shall be included in all paved areas including public or private sidewalks.
   2. Hand weed as required in addition to the application of weed control herbicides and pre-emergent to maintain all areas free of weeds including turf species other than the specified species. Periodic or predetermined weeding schedules may not be adequate and should be supplemented.
   3. Apply a final application of pre-emergent herbicide at the end of the maintenance period, just prior to final acceptance.

D. Tree basins in turf areas: Remove turf from around each tree to create a 3'-0" to 4'-0" diameter basin depending on tree size.

E. Pruning
   1. Trees: Prune trees to select and develop permanent scaffold branches; to eliminate narrow V-shaped branch forks that lack strength; to reduce topping and wind damage by thinning out crowns; to maintain a natural appearance and to balance crown with roots. All trees shall be maintained and pruned in accordance with the accepted practices of the American Society of Consulting Arborists (ASCA). Prune only as directed by the Registered Consulting Arborists and Landscape Architect.
   2. Shrubs: Same objectives as for trees. Shrubs shall not be clipped into balled or boxed forms unless such is required by the landscape plans. All pruning cuts shall be made to lateral branches, buds or flush with the trunk. Stubbing and heading shall not be permitted.
3. Only skilled workers shall perform pruning work in accordance with standard horticultural pruning practices. Remove from the project all pruned branches and material. Remove and replace any plant material excessively pruned or malformed resulting from improper pruning practices at no additional costs to the owner.

4. Improperly pruned plant material as determined by the Landscape Architect is to be replaced at no cost to the owner.

F. Staking and Guys: Stakes and guys shall remain in place through the guarantee period and shall be inspected and adjusted to prevent rubbing that causes bark wounds. Remove nursery stake from all trees that are staked with lodgepole stakes per specifications. Provide supplemental staking or guying as required during high wind events to prevent damage to trees. Any damaged tree caused by high winds must be replaced by the contractor at no cost to the owner.

G. Insect, Animal, Rodent and Disease Control: Maintain proper control with legally approved materials as required as part of the Contract.

H. Protection: The Contractor shall maintain protection of the planted areas. Damaged areas shall be repaired or replaced at the Contractor’s expense.

I. Trash: Remove trash weekly in all planted areas, pedestrian walkways and parking areas. Maintain all areas free of trash, clippings, and debris at all times.

J. Replacement: As per Guarantee and Replacement Specifications of this Section.

K. Fertilization: Fertilize all planting areas, during and just prior to end of maintenance period with the slow release maintenance fertilizer as indicated in the agronomic soils report.

L. Watering: Lawns shall be watered at such frequency as weather conditions require to replenish soil moisture below root zone and to establish healthy strands of grass.

1. Contractor is responsible for water audits and payment of any local penalties by local water districts at no additional cost to the Owner.

### 3.02 LAWN AND TURF MAINTENANCE

A. Mowing and Edging

1. Initial mowing of turf will commence when the grass has reached a height of two and one-half (2-1/2) inches. The height of cut will be two (2) inches. After initial establishment maintain Bermuda and creeping grasses at 1½” and fescues or rye grass at 2”. Mowing will be at least every 4-6 days for the second through fifth cuttings, and at least once per week after that for fescue. Bermuda grass is to be mowed minimum twice a week. Bent grass is to be mowed daily. Turf must be well established and free of bare spots and weeds to the satisfaction of the Landscape Architect prior to final acceptance.

2. Mowing of Bermuda grass needs to be done with a reel type mower only. Cool season grasses can be mowed with either a reel type mower or a rotary type mower.

3. Excess grass clippings shall be picked up and removed from the site and premises. Let turf areas dry out enough so that mower wheels do not skid, tear or mark the lawn. Edges shall be trimmed at 90 degrees to pavement, at least weekly or as needed for neat appearance.
Clippings shall be removed from paved and planting areas, etc. and disposed of from the site.

B. Watering: Lawns shall be watered at such frequency as weather conditions require to replenish soil moisture below root zone and to establish healthy strands of grass.
   1. Contractor is responsible for water audits and payment of any local penalties by local water districts at no additional cost to the Owner.

C. Disease control: Control turf diseases throughout the maintenance period with legally approved fungicides and herbicides. Replace any damaged or infected grass.

D. Weed Control:
   1. Control broad leaf weeds with selective, legally approved herbicides throughout maintenance period.
   2. A final application of selective herbicide shall be applied at the end of the landscape maintenance period, acceptance, just prior to final acceptance.
   3. Hand weed as required in addition to the application of weed control herbicides and pre-emergent to maintain all areas free of weeds including turf species other than the specified species. Periodic or predetermined weeding schedules may not be adequate and should be supplemented.

E. Fertilization:
   1. During maintenance period an application of turf maintenance fertilizer, as specified, shall be made at thirty (30) day intervals from the date of maintenance period start at a rate of five (5) pounds per 1,000 square feet, and as required by the agronomic soils report.
   2. Final application (just prior to final acceptance) shall be made with the slow-release maintenance fertilizer as required by the agronomic soils report.
   3. Replacement: At conclusion of maintenance period a final observation of lawn and turf areas shall be made. Remove diseased areas and unhealthy strands of grass from the site; do not bury into the soil. Replant areas with material and in a manner as specified on the Plans and Specifications at no additional cost to the Owner. All grass is to be fully grown with 100% coverage with a suitable thatch layer prior to turnover and final acceptance.

F. Arborist: Provide a written report and recommendations as required by the landscape architect if any plant material is in the sole opinion of the landscape architect, declining, stressed, infested, or otherwise not growing at the anticipated growth rate. The report is to include Agronomic Soils Test Data and recommendations and be provided at no cost to the owner.

3.03 IRRIGATION SYSTEM

A. System Observation: The Contractor shall check all systems for proper operation. Lateral lines shall be flushed out after removing the last sprinkler head or two at each end of the lateral. All heads are to be adjusted as necessary for unimpeded head to head coverage.

B. Valves: Contractor shall set, and verify that all pressure regulating valves to the operating pressure specified on the drawings.
C. Controllers: Set and program automatic controllers for seasonal water requirements. Give the Owner's Representative instructions on how to turn off system in case of emergency.

D. If the irrigation system is designed and specified to be operable from a central irrigation computer controller located off site, or a standard controller on site. The contractor shall demonstrate to Landscape Architect, Owner's Representative and future maintenance contractor that the central irrigation system is fully installed and operational from this off site control system as described and specified. Contractor shall make all adjustments as necessary to insure this operation prior to final acceptance.

E. Contractor shall set up and coordinate training for the Maintenance Contractor (Provider) on the irrigation controller, and pump with the manufactures representative. Maintenance period shall not end, and the project will not be accepted until this training has been completed.

F. Repairs: Repair all damages to irrigation system at the Contractor's expense. Repairs shall be made within twenty-four (24) hours or sooner to prevent damage to site improvements.

3.04 CLEANING

A. During maintenance work, keep pavements clean and work area in an orderly condition. Haul away and remove all debris from landscape areas, and do not leave any clippings, fertilizer, amendments and/or other material from landscape planting and/or maintenance period.

B. Powerwash all pavement and flatwork as necessary to remove all staining and tire marks on surfaces caused by maintenance or construction vehicles, prior to final acceptance.

END OF SECTION 32 01 90
SECTION 32 11 23

AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

1.02 RELATED REQUIREMENTS

A. Section 31 22 00 - Grading: Preparation of site for base course.
B. Section 31 23 16.13 - Trenching: Compacted fill over utility trenches under base course.
C. Section 31 23 23 - Fill: Topsoil fill at areas adjacent to aggregate base course.
D. Section 31 23 23 - Fill: Compacted fill under base course.
E. Section 32 12 16 - Asphalt Paving: Finish and binder asphalt courses.
F. Section 32 13 13 - Concrete Paving: Finish concrete surface course.
G. Section 33 05 13 - Manholes and Structures: Manholes including frames.

1.03 REFERENCE STANDARDS

D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN·m/m³)); 2012.
F. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN·m/m³)); 2012.
H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.
I. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2010.
1.04 SUBMITTALS
   A. See Section 01 3300 - Administrative Requirements, for submittal procedures.
   B. Materials Sources: Submit name of imported materials source.
   C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
   D. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. When aggregate materials need to be stored on site, locate where directed by Owner.
   B. Aggregate Storage, General:
      1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
      2. Prevent contamination.
      3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Aggregate Base: 3/4" Class 2 conforming to Caltrans Section 26 with a minimum R-value of 78.
   B. Aggregate Subbase: Class 1, conforming to Caltrans Section 25 with a minimum R-value of 60.

2.02 SOURCE QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of aggregate materials.
   B. Where aggregate materials are specified using ASTM D2487 classification, testing of samples for compliance will be provided before delivery to site.
   C. If tests indicate materials do not meet specified requirements, change material and retest.
   D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that survey monuments and intended elevations for the work are as indicated.
   B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION
   A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
   B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION
   A. Spread aggregate over prepared substrate to a total compacted thickness as indicated on plans.
B. Place aggregate in maximum 4 inch (100 mm) layers and roller compact to specified density.
C. Level and contour surfaces to elevations and gradients indicated.
D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch (6.4 mm) measured with 10 foot (3 m) straight edge.
B. Scheduled Compacted Thickness: Within 1/4 inch (6.4 mm).
C. Variation From Design Elevation: Within 1/2 inch (12.8 mm).

3.05 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor"), or ASTM D1557 ("modified Proctor").
D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
E. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade.

3.06 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 32 11 23
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Single course bituminous concrete paving.
   B. Surface sealer.

1.02 RELATED REQUIREMENTS
   A. Section 31 22 00 - Grading: Preparation of site for paving and base.
   B. Section 32 11 23 - Aggregate Base Courses: Aggregate base course.
   C. Section 32 13 13 - Concrete Paving
   D. Section 33 05 13 - Manholes and Structures: Manholes, including frames; gutter drainage grilles, covers, and frames for placement by this section.

1.03 REFERENCE STANDARDS
   A. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types; 1997.

1.04 QUALITY ASSURANCE
   A. Perform Work in accordance with Caltrans Specifications, Section 39.
   B. Mixing Plant: Conform to Caltrans Specifications, Section 39.
   C. Obtain materials from same source throughout.

1.05 REGULATORY REQUIREMENTS
   A. Conform to applicable code for paving work on public property.

1.06 SUBMITTALS
   A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1.07 FIELD CONDITIONS
   A. Do not place asphalt when ambient air or base surface temperature is less than 50 degrees F, or surface is wet or frozen.
   B. Place bitumen mixture when temperature is not more than 15 F degrees (8 C degrees) below bitumen supplier's bill of lading and not more than maximum specified temperature.
PART 2 PRODUCTS

2.01 MATERIALS
A. Asphalt Concrete: Caltrans Specifications, Section 39, Type A, 1/2 inch maximum medium hot mix.
B. Tack Coat: Emulsified asphalt.
C. Seal Coat: Caltrans Specifications, Section 37 Provide Park-Top No. 302 manufactured by Western Colloid Products.
D. Soil Sterilizer: Pramatol 25-E by CIBA CEIGY.
E. Pavement Epoxy: Ktepx-590 by K-Lite.
F. Crack Filler:
   1. Cracks up to 1/2": CAR08 by QPR
   2. Cracks 1/4" to 1": Docal 1100 Viscolastic by Conoco Inc.
   3. Cracks greater than 1": Hot Mix by Topeka

2.02 ASPHALT PAVING MIXES AND MIX DESIGN
A. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.03 SOURCE QUALITY CONTROL
A. Test mix design and samples in accordance with ASTM D 2172, California Test Method 382, or ASTM D 4125.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
B. Verify gradients and elevations of base are correct.

3.02 PREPARATION - TACK COAT
A. Apply tack coat in accordance with Greenbook, Section 302-5.4.
B. Apply tack coat to contact surfaces of curbs, gutters and pavement joints.

3.03 PLACING ASPHALT PAVEMENT - SINGLE COURSE
A. Install Work in accordance with Caltrans Specifications, Section 39.
B. Place asphalt within 24 hours of applying primer or tack coat.
C. Place to a maximum thickness of 4 inches.
D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.04 SEAL COAT
A. Apply seal coat to surface course and asphalt curbs in accordance with Caltrans Specifications, Section 37.
3.05 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch (6 mm) measured with 10 foot (3 m) straight edge.

B. Compacted Thickness: Within 1/4 inch (6 mm) of specified or indicated thickness.

C. Variation from Tru Elevation: Within 1/4 inch (6 mm).

3.06 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for quality control.

B. Provide field inspection and testing. Take samples and perform tests in accordance with California Test Method 308.

3.07 PROTECTION

A. Immediately after placement, protect pavement from mechanical injury for 2 days or until surface temperature is less than 140 degrees F (60 degrees C).

END OF SECTION 32 12 16
PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Walks.
B. Stairs and ramps.
C. Mow strips.
D. Detectable warnings.

1.02 RELATED REQUIREMENTS
A. Division 03 Section Cast-in-Place Concrete
B. Division 05 Section Metal Fabrications
C. Division 05 Section Pipe and Tube Railings.
D. Division 05 Section Decorative Metal Railings
E. Division 31 Section Earthwork
F. Division 32 Section Architectural Site Concrete
G. Division 32 Section Concrete Paving Joint Sealants
H. Division 32 Section Chain Link Fences and Gates
I. Division 32 Section Decorative Metal Fences and Gates

1.03 DEFINITIONS
A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: Fly ash and other pozzolans, and ground granulated blast-furnace slag, subject to compliance with requirements.

1.04 PREINSTALLATION CONFERENCE
A. Conduct conference at Project site two weeks prior to start of work of this section. Required attendance of all affected installers.
1. Review methods and procedures related to concrete paving, including but not limited to, the following:
2. Concrete mixture design
3. Testing and inspection procedures.
4. Concrete finishes and finishing.
5. Cold- and hot-weather concreting procedures.
6. Curing procedures.
7. Construction joints.
10. Concrete repair procedures.
12. Review special testing and inspection procedures.
13. Placement sequence and schedule.
14. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete paving subcontractor.
e. District's Representative
f. Architect's Representative
g. Inspector of Record
h. Manufacturer's representative for specialty concrete paving finishes.
i. Provide meeting minutes for pre-installation conference

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Proprietary admixtures, pigments, curing compounds, hardeners, sealers, form-release agents, etc.: Indicate compatibility with other materials used.
   2. Stenciling material

B. LEED Submittals:
   1. Product Data for Credit MR 4.1[and Credit MR 4.2]: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.
   2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for Portland cement or other Portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain Portland cement replacements, to determine amount of Portland cement replaced.

C. Samples for Initial Selection: For each type of product, finish, ingredient, or admixture requiring color selection.
   1. Submit full range of manufacturer’s standard and custom range of colors and products for review and selection. Provide custom colors on samples as required. Upon selection of color, submit 12”x12” sample of material in the specified color finish for review by Landscape Architect in addition to the specified mock ups.

D. Design Mixtures: Submit proposed mix designs and test data for each class of concrete and for each method of placement.
   1. Prepare mix designs on the basis of field experience (preferred) and/or trial mixes, in compliance with California Building Code (CBC), Section 1905A.3.
   2. Prepare mix designs on the basis of field experience (preferred) and/or trial mixes, in compliance with California Building Code (CBC), Section 1905.3.
   3. Mix designs shall be prepared, stamped and signed by a structural or civil engineer registered in the State of California.
      a. Mix designs shall be reviewed by the Architect (AOR) and Structural Engineer of Record (SEOR).
   4. Identify for each mix design submitted the method by which proportions have been selected.
      a. For mix designs based on field experience, include individual strength test results, standard deviation, and required average compressive strength $f_c$ calculations.
b. For mix designs based on trial mixtures, include trial mix
proportions, test results, graphical analysis and show required
average compressive strength \( f'c \) results. Provide gross weight and
yield per cubic yard of trial mixes.

c. Indicate quantity of each ingredient per cubic yard of concrete and
percentages.

d. Indicate type and quantity of admixtures proposed or required.

e. Indicate water to cement ratio by weight.

f. Measured slump.

g. Measured air content.

h. Provide shrinkage test results.

5. Multiple mix designs or multiple manufacturers shall not be permitted
for the same application.

E. Mix designs should contain no fly ash.

F. Submit proposed alternate design mixtures for review by the Architect and
SEOR when characteristics of materials, Project conditions, weather, test
results, or other circumstances warrant adjustments.

G. Steel Reinforcement Shop Drawings: Placing drawings that detail
fabrication, bending, and placement. Include bar sizes, lengths, material,
grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement,
splices and laps, mechanical connections, tie spacing, hoop spacing, and
supports for concrete reinforcement. Shop drawings should include details
such as reveals, recessed lights, handrails, or other elements requiring steel
coordination.

1. Coordinate with and identify the details of the Contract Drawings on
the shop drawings.

2. Comply with ACI 315, part B and CRSI requirements.

H. Construction Joint Layout: Indicate proposed construction joints required
to construct the structure. Submit dimensioned drawing indicating layout
of construction joints, contraction (control) joints, dowelled joints,
decorative scoring and placement sequence of concrete if different than
layout indicated on plans.

1. Location of construction joints are subject to approval of the Architect.

2. All form seams are to align with construction joints or reveals.

I. Placement Schedule: Submit concrete placement schedule before start of
placement operations. Include locations of all joints including construction
joints.

J. Pavement-Marking Shop Drawings: Indicate pavement markings, lane
separations, and defined parking spaces. Indicate, with international
symbol of accessibility, spaces allocated for people with disabilities.

K. Qualification Data: For qualified ready-mix concrete manufacturer (batch
plant)[ and installer of detectable warnings].

L. Welding Certificates: Submit certifications signed by AWS Certified Welding
Inspector of prequalified welding procedures, qualifications of welding
procedures unless prequalified, qualifications of welding operators and
qualifications of welders.

M. Material Certificates: For the following, submit manufacturer data, test
results, and technical information for aggregate, sand and cement, submit
\( \frac{1}{2} \) cubic foot physical sample. For sealant submit manufacturer color
standard and custom palette together with physical samples:
1. Cementitious materials.
2. Aggregates and sand.
3. Steel reinforcement and reinforcement accessories.
4. Fiber reinforcement.
5. Admixtures.
6. Curing compounds.
8. Bonding agent and epoxy adhesives.
10. Sealer
11. Sealant.

N. Material Test Reports: For each of the following:
   1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

O. Detectable Warning Device Warranty: Submit copies of manufacture's five year warranty for each of these products and manufacturer custom and standard color palette.

P. Field quality-control reports.
   1. Submit copies of delivery tickets complying with ASTM C 94 for each load of concrete delivered to the site. Tickets shall include all information required by the referenced standard.

Q. Minutes of pre-installation conference.

1.06 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with CBC Chapter 19A.
   1. Chemical products field-applied to concrete shall comply with the air quality requirements of authorities having jurisdiction.
   2. Comply with requirements of local, State and other authorities having jurisdiction for work performed within public right-of-ways.

B. Regulatory Requirements: Comply with CBC Chapter 19.

C. Chemical products field-applied to concrete shall comply with the air quality requirements of authorities having jurisdiction.

D. Comply with requirements of local, State and other authorities having jurisdiction for work performed within public right-of-ways.

E. Industry Standards: Comply with the following unless modified by requirements in the Contract Documents.
   1. ACI 301, "Specifications for Structural Concrete".
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".
   3. ACI 302.1R, "Guide for Concrete Floor and Slab Construction".
   4. ACI 304R, "Guide for Measuring, Mixing, Transporting, and Placing Concrete".
   5. ACI 305R, "Hot Weather Concreting".
   7. ACI 318, "Building Code Requirements for Structural Concrete".
   8. ACI 347, "Guide to Formwork for Concrete".
   9. ACI SP-66, "ACI Detailing Manual".
10. CRSI, "Manual of Standard Practice".
11. CRSI, "Placing Reinforcing Bars".

CONCRETE PAVING
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F. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of cast-in-place, surface-applied unit-paver-type detectable truncated dome products.

G. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

H. Source Limitations for Concrete Paving: Obtain each color, size, type, and variety of concrete material and concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties. Secure all material required for the duration of the project as needed to ensure consistent quality in appearance.

I. Welding Qualifications: Comply with CBC Chapter 17A.
   1. Qualify welding procedures and welding personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel" prior to performing any welding.
   2. Qualify welding inspection personnel according to AWS QC1, "Standard for AWS Certification of Welding Inspectors."

J. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

K. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

L. ACI Publications: Comply with ACI 301 unless otherwise indicated.

M. Mockups: Before casting concrete paving, build mockups to verify selections made under Sample submittals and to fully demonstrate typical joints (including expansion and saw cut joints), surface finish, texture, color tolerances, standard of workmanship and completed product. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
      a. Paving Modules: Construct at least one 6 ft. x 6 ft. mockup of each color, finish, and mix design of special paving module, including stenciled areas, banding and curbs
      b. Radial Paving Patterns: Construct at least one 180 sq. ft. mockup of curved or radial paving patterns.
      c. Detectable Warnings: Grooves minimum 12 inches X 6 ft. long.
      d. Stairs: Construct minimum 2 risers and treads X 4’ long with nosing grooves and stained color within grooves for each color and finish specified.
      e. Mow Strip: minimum 6’ long for each specified width and color.
      f. Truncated Domes: minimum 3’X6’ long set in concrete with concrete base and grout.
      g. Repairs: In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes, honeycombing, spalls, surface blemishes, etc. to match adjacent undamaged surfaces.
2. Build mockups full-size, matching site concrete components indicated on the Drawings. Mock-ups shall be complete in every detail, including joints, reveals, edges, chamfers, etc. Include complex joinery conditions where necessary to integrate to other Project components as indicated including multiple pour conditions. Mockups should be provided for each finish, color, joint and detail specified.

3. Maintain accurate records of variables associated with each mockup to facilitate the matching of accepted mockups during actual construction.

4. Demonstrate curing, cleaning, and protecting of cast-in-place concrete paving, finishes, and contraction and expansion joints, as applicable.

5. Mockup Acceptance: Obtain Architect’s approval of mockups before casting architectural site concrete and paving.
   a. The Architect may reject mockups that, in the Architect's sole judgment, do not demonstrate an acceptable completed product, including, but not limited to, color, joint work, surface finish, texture, tolerances, and standard of workmanship
   b. The Architect may require modifications to mockups to obtain acceptable results.
   c. The Architect may require modifications to mockup repairs to obtain acceptable results.
   d. The Architect may require removal and reconstruction of mockups to obtain acceptable results. Multiple mock ups maybe required.
   e. Contractor shall provide additional mockups as required to obtain results acceptable to the Architect at no additional cost to the Owner.

6. Mockup Disposition: Accepted mockups shall not become part of the completed Project. Maintain mockup onsite for the duration of construction and until all work has been accepted. Remove and legally dispose mockups after acceptance of final installed work. prior to Project Completion. If sufficient permanent concrete paving work has been completed, Contractor may submit a written request to Architect to transfer quality control for concrete paving from the accepted mockups to one or more designated portions of the permanent work.

7. Provide written meeting minutes for each mock up review indicating items reviewed, approvals, rejections, connections, or other action items.

1.07 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending, damage, and rust.
   1. Label bundles with durable identification tags. Maintain reinforcement identification after bundles are broken.
   2. Store reinforcement to avoid excessive rusting or fouling with grease, oil, dirt or other bond-weakening contaminants.
   3. Avoid damaging applied coatings, if any, on steel reinforcement.
PART 2 - PRODUCTS

2.01 FORMS

A. Formwork: Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth surfaces.

1. Set forms to alignment, grade and required dimensions. Formwork shall not deviate more than 1/4 inch from required vertical positions and 1/4 inch from required horizontal positions. Exposed Surfaces: Provide faced plywood panels complying with, or equivalent to, DOC PS 1, Structural I. Provide minimum 7-ply plywood and provide balance sheets for panels coated one-side only. Furnish in largest practicable sizes to minimize number of joints. Provide Medium-Density Overlay (MDO) panels or high density overlay (HDO) panels, with mill-applied release agent and edge sealant. Provide one of the following panels, or comparable substituted product:

2. Hold forms rigidly in place by stakes, clamps, spreaders, and braces at 3 feet on centers, and where required to ensure rigidity.

3. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

4. Place joint filler or backer rod on vertical surfaces in contact with concrete paving.

5. Benders or thin plank forms may be used on curves, grade changes, or curb returns. Back forms for curb returns may be made of ½-inch thick benders cleated together for full depth of the curb.

6. Keep forms in place until concrete is sufficiently hard to prevent damage to concrete.

7. Reuse of Forms:
   a. Do not reuse forms if there is any evidence of surface wear or defect which would impair quality of surface or edge.
   b. Thoroughly clean and properly coat forms before reuse.
   c. Do not use forms from previous projects.

8. Provide new forms specifically purchased for this project. Reuse of forms from past projects or contractors stock will not be accepted.

B. Curved Work: Kerf back of plywood form-facing panels, or use accepted flexible or curved forms for curved work with a radius of 100 feet or less.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

1. Obtain written acceptance of form release agent from integral colored concrete pigment manufacturer.

2. Form-release agents shall be non-staining and can cause no visual effect to the finish.

2.02 STEEL REINFORCEMENT

A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than 60 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.


E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

F. Low-Alloy-Steel Reinforcing Bars (for Welding): ASTM A 706/A 706M, Grade 60, deformed, unless otherwise indicated.

G. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
   1. Provide two-component "Speed Dowel System" manufactured by Greenstreak.

H. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

I. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

J. 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 specified, and as follows:
   1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

K. Zinc Repair Material: ASTM A 780.

2.03 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
   1. Portland Cement: ASTM C 150, Type II/V, Type I/II or Type IV, gray, unless white cement is required to achieve colors indicated.
      Supplement with the following:
      a. Flay Ash: none accepted.

B. Normal-Weight Aggregates: ASTM C 33, complying with building code. Provide aggregates from a single source. All aggregates shall be free of materials with deleterious reactivity to alkali in cement when tested in accordance with ASTM C 289.
   1. Comply with CBC section 1903A.3.
   2. Comply with CBC section 1903.3.
   3. Service Class, based on CBC Figure 1904A.2.2, "Weathering Probability Map":
      a. Severe and Moderate: Class 5S.
      b. Negligible: Class 2N.
4. Service Class, based on CBC Figure 1904.2.2, "Weathering Probability Map":
   a. Severe and Moderate: Class 5S.
   b. Negligible: Class 2N.

   a. Source: Relliance, Vulcan, San Gabriel, or Carrol Canyon
   b. No pea gravel will be accepted.

   a. Source: Relliance, Foster, Corona
   b. Color to be white to light no dark material.


D. Water: Potable and complying with ASTM C 94/C 94M.

E. Shrinkage-Reducing Admixture: Commercially formulated, shrinkage inhibitor capable of reducing initial shrinkage by 80% and long-term shrinkage by 50%. Provide product suitable for use with either air-entrained or non-air-entrained concrete as appropriate to structural member and project location.
   1. Products: Subject to compliance with requirements, provide one of the following (as required):
      a. Euclid Chemical Company (The), an RPM company; EUCON SRA, SRA+.
      c. Sika Corporation; Control 40.

F. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Davis Colors - Liquid
      b. QC Construction Products - Liquid
      c. Scofield, L. M. Company: Chromix - L
      d. Solomon Colors, Inc. - Liquid
   2. Color: As indicated on plans.

2.04 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete. Provide products with not more than 100g/L volatile organic content.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. BASF Construction Chemicals, LLC; Confirm.
      b. Conspec by Dayton Superior; Aquafilm.
      c. Nox-Crete Products Group; MONOFILM.
E. Clear, Waterborne, Membrane-Forming Curing Compound (Colored Concrete): Provide products that are acceptable to concrete color pigment manufacturer complying with ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of sealers with no glossy finish and compatible with specified sealer. Provide products with not more than 100g/L volatile organic content.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Sinak Corporation; The Cure WCE or Lithium Cure 1000.
   b. L. M. Scofield; Cureseal-W.
   c. Butterfield Color; Clear Guard H2O.

F. All curing materials should be dissipating without leaving a shiny, cloudy, or glossy finish. Curing material does not substitute requirement of a sealer.

2.05 HARDENERS AND SEALERS

A. Penetrating Liquid Floor and Horizontal Surface Treatment (Sealer): Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate water-based lithium quartz materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces. Materials shall be compatible with concrete admixtures and shall be recommended by manufacturer for intended use. Provide product with 0g/L volatile organic content.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Sinak Corporation; Concrete Sealer HLQ 125.
   b. L. M. Scofield; Cureseal-W.
   c. Butterfield Color; Clear Guard H2O.
   d. BASF Construction Chemicals - Building Systems; Kure-N-Harden.
   e. Dayton Superior Corporation; Edoco by Dayton Superior; Titan Hard.
   f. Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
   g. L&M Construction Chemicals, Inc.; Seal Hard.

2.06 AGGREGATE BASE

A. Granular Fill: Class II crushed aggregate per Section 26 of Cal-Trans standards. Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch (9.5-mm), 20 to 10 / 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and at least 0-5 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

2.07 RELATED MATERIALS

A. Joint Fillers:
   1. ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.
   3. 1/4" thickness.
B. Bonding Agent: ASTM C 1059, Type II, non-re-emulsifiable. Provide proprietary products composed of latex polymers.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. W. R. Meadows, Inc.; "Acry-Lok".
      b. Grace Construction Products, W. R. Grace & Co.; "Daraweld C".
      c. Larsen Products Corp., "Weld-Crete".

C. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of Portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. BASF Construction Chemicals, LLC; Mastercron.
      b. L&M Construction Chemicals, Inc.; QUARTZPLATE FF
      c. Scofield, L. M. Company; LITHOCHROME Color Hardener.
      f. Conspec by Dayton Superior; Conshake 600 Colortone.
      g. Dayton Superior Corporation; Quartz Tuff.
      h. Euclid Chemical Company (The), an RPM company; Surlfix.
      i. Lambert Corporation; COLORHARD.
      j. Metalcrete Industries; Floor Quartz.
      k. Southern Color N.A., Inc.; Mosaics Color Hardener.
      l. Symons by Dayton Superior; Hard Top.
      m. <Insert manufacturer's name; product name or designation>.
      n. Color: As selected by Architect from manufacturer's full range.

2.08 DETECTABLE WARNING MATERIALS

A. General: All detectable warning systems shall comply with Americans with Disabilities Act (28 CFR Part 36 ADA Standards for Accessible Design, Appendix A, Section 4.29.2 Detectable Warnings on Walking Surfaces), and CBC requirements (Section 11B-24, 11B-705 and others). All detectable warning materials shall have raised truncated domes with a base diameter of nominal 0.90 inch (22.9 mm), tapering to a top diameter of 0.45 inch (11.4 mm), a height of nominal 0.20 inch (5.08 mm), and a center-to-center spacing of 2.35 inches (59.7 mm) nominal. The orientation of the dome pattern for all panels shall be parallel with the panel edges. Detectable warning materials shall visually contrast with surrounding areas.

1. California Compliance Warranty: All detectable warning systems shall be approved by DSA-AC. If not approved, DSA will accept a written five (5) year product warranty provided by the manufacturer of detectable warning products and directional surfaces. Such warranty shall indicate compliance with architectural standards as published in the current edition of the California Building Standards Code, and also include durability criteria which indicate that the shape, color fastness, confirmation, sound-on-cane acoustic quality, resilience, and attachment will not degrade significantly for at least five (5) years after initial installation. As defined by the State, "not degrade significantly" means that the product maintains at least 90 percent of its approved design characteristics, as determined by the enforcing agency.

B. Safety Step TD (Surfaced Truncated Domes)
1. Traditional System
2. Ramp Up System

C. Concrete Paver Detectable Dome Warning System: Provide standard size precast architectural concrete paving units for installation in sand or mortar beds.
1. Basis-of-Design Product: Provide the following, or comparable substitute product:
      1) Size: per approved plans and details. Nominal 12 inches by 12 inches by 2 3/8 inches (4.7 cm by 4.7 cm by 6 cm).
      2) Color: per approved plans and details. As selected by Architect from manufacturer's complete range.
   b. Wausau Tile - ADA-2 Truncated dome pavers.
      1) 12 inches by 12 inches by 2 3/8 inches
      2) Color as selected by Architect from manufacturer's complete range.

2.09 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. Proportioning:
   a. The proportioning of ingredients shall be such that the concrete can be readily worked into forms and around reinforcement under the conditions of placement to be used, without segregation or excessive bleeding.
   b. When proportioning by weight of loose, dry material, 94 pounds of cement shall be considered 1 cubic foot.
      1) Fine aggregate volume shall be at least 35 percent, with a maximum of 50 percent, of the sum of the separate fine and coarse aggregate volumes.
      2) Broom Finish: Coarse aggregate 50 percent-50 percent fine aggregate.
      3) Abrasive blast finish: Coarse aggregate 40 percent, fine aggregate 60 percent.
      4) Exposed aggregate: Coarse aggregate 60 percent, fine aggregate 40 percent.
   c. Total water content shall not exceed 35 gallons per cubic yard of concrete.
   d. Weighing equipment shall be accurate within 1 pound and shall be adjustable for varying aggregate moisture content.
   e. A beam auxiliary shall register any part of the last 100 pounds of each aggregate. The aggregate hopper shall have a volume adjustment.
3. Prepare compressive strength data for both 7-day and 28-day strengths.
   a. The 7-day compressive strength shall be at least 60 percent of the required 28-day strength.
   b. The 28-day compressive strength shall be as indicated.
   c. Provide drying shrinkage test data at 28 days, from not less than 3 test specimens.
B. When automatic machine placement is used, prepare and submit design mixtures suitable for use with machine placement, including reduced slump as required. Obtain laboratory test results that meet or exceed requirements.

C. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Typical Compressive Strength (28 Days): Provide the following minimum compressive strength (28 days) for concrete paving unless otherwise indicated: 3000 psi.

2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50-0.60.

3. Slump Limit: 4 inches, plus or minus 1 inch, unless indicated otherwise.
   a. Slump Limit (High-Range Water-reducing Admixture): 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture, plus or minus 1 inch, unless indicated otherwise.
   b. Slump Limit (Plasticizing Admixture): 8 inches for concrete with verified slump of 2 to 4 inches before adding plasticizing admixture, plus or minus 1 inch, if required.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement. Limit total chloride-ion content in hardened concrete to 0.10 percent by weight of concrete when tested per AASHTO T 260 potentiometric titration.

E. Limit "drying shrinkage" after 28 days of curing hardened concrete to 0.045 percent of the original concrete volume.

F. Limit water-soluble, chloride-ion content in hardened concrete to [0.15] [0.30] percent by weight of cement.

G. Chemical Admixtures: Admixtures may only be used if they are incorporated into the accepted concrete mix designs. Use admixtures according to manufacturer's written instructions.

1. Use [water-reducing admixture] [high-range, water-reducing admixture] [high-range, water-reducing and retarding admixture] [plasticizing and retarding admixture] in concrete as required for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

H. Liquid Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with accepted mockup.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M[ and ASTM C 1116/C 1116M]. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between 85 and 90 deg. F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg. F (32 deg C), reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

C. For concrete batches of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

D. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.

E. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

F. Integral Colored Concrete Mixes: Add pigments at the concrete batch plant. Minimum batch size shall be three (3) yards. The same brand of cement, source of sand, and water/cement ratio shall be maintained for each load of the same color.

1. Batching Procedure: Before adding color-conditioning admixture, the mixing drum shall be thoroughly cleaned and wetted with approximately 40 gallons of the mix water and/or a portion of the aggregates. After cleaning and wetting of the drum, add the specified quantity of admixture correctly packaged for the mix design and batch quantity. Proceed with normal batching of balance of ingredients. After loading is complete, mix at mixing speed for a minimum of 15 minutes. Do not add water after a portion of the load has been discharged.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.

2. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."

C. Proceed with concrete paving installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides 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.

C. Slope stair and step treads at not less than 1.0 percent and not more than 2.0 percent cross slope to drain.

### 3.04 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.

D. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

### 3.05 JOINTS

A. General: Form construction, isolation or expansion joint, and saw cut / contraction joints and tool edges 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 paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Isolation (Expansion) Expansion Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
   1. Locate expansion joints at intervals of 20 feet maximum unless otherwise indicated.
   2. Extend joint fillers full width and depth of joint and recess 1 inch from finish surface where no joint sealant is indicated.
   3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
   4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   5. Break steel at expansion joints.
   6. Dowels- provide prefabricated ‘speed dowel’ assemblies.

C. Saw Cut (Control) Joints: Form weakened-plane saw cut joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth plus 1/4 inch of the concrete thickness, as follows, and to match jointing of existing adjacent concrete paving:
   1. Continue steel reinforcement across sawcut joints unless otherwise indicated.
D. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/8-inch radius unless otherwise noted. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in. Notify other trades as necessary to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and steel 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. Do not add water to fresh concrete after testing.

F. 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.

G. 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, and side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. 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.

J. Curbs and Gutters: Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use accepted design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

L. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

M. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg. F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg. F (10 deg C) and not more than 80 deg. F (27 deg C) at 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 design mixtures.

N. Hot-Weather Placement: Comply with ACI 305R (ACI 305R M) and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg. F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in 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.

O. Provide sand and base materials as indicated.

3.07 FLOAT FINISHING
A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
   2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture. Required to meet slip coefficient requirement.
   3. Portland cement concrete paving shall be stable, firm, and slip resistant and shall comply with CBCSections 11B-302 and 11B-403.

3.08 DETECTABLE WARNINGS
A. Detectable Warnings, General: Install detectable warnings as part of the concrete paving placement sequence. Set true to line and elevation. Comply with maximum slope and cross-slope requirements for accessible walkways.
   1. Blockouts: Form blockouts in concrete and asphalt pavements for installation of detectable paving units.
      a. Tolerance for Opening Size: Plus 1/4 inch, no minus.

B. Detectable warnings surfaces shall comply with CBC Section 11B-705.1.

C. Detectable warning surfaces shall be yellow conforming to FS 33538 of Federal Standard 595C, except for locations at curb ramps, islands, or cut through medians where color used shall contrast visually with that of adjacent walking surfaces, either light-on-dark or dark-on-light. CBC Sections 11B-705.1.1.3 and 11B-705.1.1.5.
D. Detectable warning surfaces shall differ from adjoining surfaces in resiliency or sound-on-cane contact. **CBC Section 11B-705.1.1.4.**

E. Provide 5 year minimum warranty per **DSA Bulletin 10/31/02, revised 04/09/08.**

F. Precast Detectable Warning Tiles: Comply with approved plans and details along with manufacturer's written instructions.

G. Surface-Mounted Detectable Warning Tiles: Comply with manufacturer's written instructions. Do not install directly over asphalt pavements.

H. For installation at asphalt pavements, comply with installation indicated on Drawings. If not indicated, provide one of the following installation methods:

I. Saw-cut and remove asphalt pavement in location of warning tile to a minimum depth of 6 inches. Replace removed pavement materials with reinforced concrete paving materials. When cured, install surface-mounted detectable warning tiles.

J. Provide 0.032 inch aluminum separation sheet cut to same size as surface mounted tiles. Adhere sheet to asphalt paving with a thin coat of urethane adhesive, holding adhesive 1 inch from edge of sheet. Install surface-mounted detectable warning tiles to sheet with adhesive and mechanical fasteners per manufacturer's written instructions.

K. Cast-in-Place Detectable Warning Pavers: Integrate into installation of unit pavers. Comply with manufacturer's written instructions.

L. Cast-in-Place Detectable Warning Grooves: Install detectable warnings as part of the concrete paving placement sequence. Set true to line and elevation. Form well-defined, clean grooves with appropriate tools.

### 3.09 CONCRETE PROTECTION, CURING AND SEALING:

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. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. **Moisture Curing:** Keep surfaces continuously moist for not less than 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.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer’s written instructions. Recoil areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

F. Seal Concrete: Apply specified sealer in accordance with manufacturer’s recommendations.
   1. Apply full strength in two coats with airless sprayer at the manufacturer’s recommended rate.
   2. After the first coat is completely dry, apply second coat at right angles to the first coat.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117, the Americans with Disabilities Act, the CBC and as follows:
   1. Elevation: 1/8 inch.
   4. Surface Discontinuities: Maximum 1/4 inch, subject to further limitations of accessible routes.
   5. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
   8. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/8 inch per 12 inches of dowel.
   9. Joint Spacing: 3 inches, except joint position shall be within 1/4 inch of objects in alignment with joint such as benches, light poles, pull boxes, etc.
   10. Sawcut Joint Depth: Plus 1/4 inch, no minus.

B. Stair Treads: Stair treads within a run shall be constructed equally and shall shed water away from the path of travel. Maximum tread slope down from riser to nosing in direction of travel: 1.0 percent, plus or minus 0.5 percent. Maximum tread cross-slope perpendicular to direction of travel: 2.0 percent, plus 0.0 percent, minus 1.0 percent or as required to shed water.

C. Ramps: Ramps shall shed water away from the path of travel. Maximum ramp slope in direction of travel: 8.33 percent. Maximum ramp cross-slope perpendicular to direction of travel: 2.0 percent, plus 0.0 percent, minus 1.0 percent or as required to shed water.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
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 one composite sample for each 20 cu. Yd., or fraction thereof of each concrete mixture placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg. F and below and when it is 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 one specimen at seven days and two specimens at 28 days.
   a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Owner, 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. Concrete paving will be considered defective if it does not pass tests and inspections.
H. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, cracked, chipped, stained or defective or that does not comply with requirements in this Section as determined by Landscape Architect. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with Portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude all but pedestrian traffic from paving for at least 28 days after placement. When construction traffic is permitted, maintain paving as clean as possible by providing adequate surface protection and by removing surface stains and spillage of materials as they occur.
   1. Rubber tire marks are unacceptable in the completed construction.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Project Completion inspections.

E. Repair of damaged, defective or rejected concrete is not permitted. Remove all concrete from expansion joint to expansion joint or greater as required to provide a constant continuous finish.

3.13 FINAL CLEANING

A. Remove all excess concrete, form materials, over pours, waste, etc., and legally dispose off-site.

B. Provide a final acid and power wash for all concrete paving surfaces. Do not use any material that will affect the appearance of the concrete.

C. All over pours in planting areas should be removed prior to landscape operations.

D. Clean concrete paving to remove stains, markings, dust, and debris.

END OF SECTION 32 13 13
SECTION 32 13 73

PAVEMENT JOINT SEALERS

PART 1 - GENERAL

1.01 SECTION INCLUDES: RELATED DOCUMENTS
A. Exterior joint sealant for non-traffic surfaces.

1.02 RELATED REQUIREMENTS
A. Division 32 Section Concrete Paving.
B. Division 32 Section Architectural Site Concrete

1.03 SUBMITTALS
A. Product Data: For each joint-sealant product indicated.
B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- (13-mm-) and 1/4-inch (6.4-mm) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.04 QUALITY ASSURANCE
A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.
B. Store and handle materials to comply with manufacturer’s written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 PROJECT CONDITIONS
A. Do not proceed with installation of joint sealants under the following conditions:
B. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (4.4 deg C).
C. When joint substrates are wet or covered with frost.
D. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
E. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL
A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
B. Colors of Exposed Joint Sealants: As selected by Landscape Architect from manufacturer's full range.

2.03 ELASTOMERIC JOINT SEALANTS
A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

2.04 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. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

PART 3 EXECUTION

3.01 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.

3.02 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.
3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install backer materials of type indicated to support 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 backer materials.
   2. Do not stretch, twist, puncture, or tear backer materials.
   3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses provided for 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.

F. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.04 CLEANING

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

3.05 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 with repaired areas are indistinguishable from the original work.

3.06 SCHEDULE

A. Horizontal Joints, less than 5 percent slope; Sealant No. 1.
B. Horizontal Joints, grades steeper than 5 percent; Sealant No. 2
C. Vertical Joints; Sealant No. 2

END OF SECTION 32 13 73
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Precast concrete parking bumpers and anchorage.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide unit configuration, dimensions.
C. Samples: Submit two concrete bumper units, illustrating surface finish.

PART 2 PRODUCTS

2.01 MATERIALS
A. Parking Bumpers: Precast concrete, conforming to the following:
   1. Nominal Size: 8 inches (203 mm) high, 9 inches (229 mm) wide, 5 or 7 feet (1524 or 1778 m) long. Refer to plans for length.
   4. Reinforcing Steel: ASTM A615/A615M, deformed steel bars; unfinished, strength and size commensurate with precast unit design.
   5. Air Entrainment Admixture: ASTM C260/C260M.
   6. Concrete Mix: Minimum 5,000 psi (34 MPa) compressive strength after 28 days, air entrained to 5 to 7 percent.
   7. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during manufacture.
   8. Embed reinforcing steel, and drill or sleeve for two dowels.
   9. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
   10. Minor patching in plant is acceptable, providing appearance of units is not impaired.
B. Dowels: Cut reinforcing steel, 1/2 inch (12 mm) diameter, 24 inch (610 mm) long, pointed tip.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install units without damage to shape or finish. Replace or repair damaged units.
B. Install units in alignment with adjacent work.
C. Fasten units in place with 2 dowels per unit.

END OF SECTION 32 17 13
PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, and curb markings.

B. "No Parking" curb painting.

1.02 RELATED REQUIREMENTS

A. Section 32 12 16 - Asphalt Paving.

B. Section 32 13 13 - Concrete Paving.

1.03 REFERENCE STANDARDS


1.04 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. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint in containers of at least 5 gallons (18 L) accompanied by batch certificate.

B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment accompanied by batch certificate.

C. Store products in manufacturer's unopened packaging until ready for installation.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.
PART 2 PRODUCTS

2.01 MATERIALS

A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.

B. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Clean surfaces thoroughly prior to installation.
   1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
   2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement, by scraping, wire brushing, sandblasting, mechanical abrasion, or approved chemicals.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

3.03 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 35 degrees F (___ degrees C) or more than 95 degrees F (35 degrees C).

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with California MUTCD manual for details not shown.

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends.
   1. Length Tolerance: Plus or minus 3 inches (75 mm).
   2. Width Tolerance: Plus or minus 1/8 inch (3 mm).

G. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
   1. Mark the International Handicapped Symbol at indicated parking spaces.
   2. Hand application by pneumatic spray is acceptable.

H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.04 DRYING, PROTECTION, AND REPLACEMENT

A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.

C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.

D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.

F. Replace removed markings at no additional cost to Owner.

END OF SECTION 32 17 23.13
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Fence framework, fabric, and accessories.
B. Excavation for post bases; concrete foundation for posts.
C. Manual gates and related hardware.

1.02  RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete anchorage for posts.
B. Section 08 71 00 - Door Hardware: Gate locking device.
C. Section 33 79 00 - Site Grounding.

1.03  REFERENCE STANDARDS

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
G. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric; 2011.
J. ASTM F1665 - Standard Specification for Poly(Vinyl Chloride)(PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used with Chain-Link Fence; 2008 (Reapproved 2013).

1.04  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
C. Shop Drawings: Indicate in plan layout and elevation, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.

D. Manufacturer's Installation Instructions: Indicate installation requirements, post foundation anchor bolt templates, and anchor

E. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Chain Link Fences and Gates:
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS


C. Concrete: Ready-mixed, complying with ASTM C 94/C 94M; normal Portland cement; 2,500 psi (17 MPa) strength at 28 days, 3 inch (75 mm) slump; 1.5 inch (38 mm) nominal size aggregate.

2.03 COMPONENTS

A. Line Posts: 2.38 inch (60 mm) diameter.

B. Corner and Terminal Posts: 4.0 inch (100 mm).

C. Gate Posts: 6.0 inch (155 mm) diameter.

D. Top and Brace Rail: 1.66 inch (42 mm) diameter, plain end, sleeve coupled.

E. Gate Frame: 1.66 inch (42 mm) diameter for welded fabrication.

F. Fabric: 2 inch (51 mm) diamond mesh interwoven wire, 6 gage, 0.1620 inch (4.12 mm) thick, top selvage knuckle end closed, bottom selvage twisted tight.

G. Tension Wire: 9 gage (3.75 mm) thick steel, single strand.

H. Tension Band: 3/8 inch (9.5 mm) thick steel.

I. Tie Wire: Aluminum alloy steel wire.

2.04 ACCESSORIES/HARDWARE

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.
C. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches (1525 mm) high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

D. Hardware for Double Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches (1525 mm) high, 3 for taller gates; drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position.

E. Privacy Slats: Vinyl strips, sized to fit fabric weave.

F. Gates that are part of the accessible route shall meet all the requirements of an accessible door in compliance with CBC Section 11B-404.

G. The lever of lever actuated latches or locks for an accessible gate shall be curved with a return to within 1/2" of the (face of) gate to prevent catching on the clothing or persons. California Referenced Standards code. T-24 part 12, Section 12-10-202, Item (F).

H. Swing doors and gate surfaces within 10" of the finish floor or ground shall have a smooth surface on the push side extending the full width of the door or gate. Parts creating horizontal or vertical joints in these surfaces shall be within 1/16" of the same plane as the other and be free of sharp or abrasive edges. Cavities created by added kick plates shall be capped. CBC Section 11B-404.2.10

I. The clear opening width for a door shall be 32" minimum. For a swinging doors it shall be measured between the face of the door and the stop, with the door open 90 degrees. There shall be no projections into it below 34" and 4" maximum projections into it between 34" and 80" above the finish floor or ground. Door closers and stops shall be permitted to be 78" minimum above the finish floor or ground. CBC Section 11B-404.2.3

J. Handles pulls, latches, locks, and other operable parts on accessible doors shall comply with CBC Section 11B-309.4 and shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. Operable parts of such hardware shall be 34" minimum and 44" maximum above finish floor or ground. Where sliding doors are in the fully open position, operating hardware shall be exposed and usable from both sides. CBC Section 11B-404.2.7

K. The force for pushing or pulling open a door shall be as follows: CBC Section 11B-404.2.9
   1. Interior hinged doors, sliding or folding doors: 5 pounds (22.2N) maximum. Required fire doors: the minimum opening force allowable by the DSA authority, not to exceed 15 pounds (67N). These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position.
   2. The force required for activating any operable parts, such as lever hardware, or disengaging other devices shall be 5 pounds (22.2N) maximum to comply with CBC Section 11B-309.4

L. Door closing speed shall be as follows: CBC Section 11B-404.2.8
   1. Closer shall be adjusted so that the required time to move a door from an open position of 90 degrees to a position of 12 degrees from the latch is 5 seconds min.
2. Spring hinges shall be adjusted so that the required time to move a door from an open position of 70 degrees to the closed position is 1.5 seconds minimum.

M. Thresholds shall comply with CBC Section 11B-404.2.5

N. Floor stops shall not be located in the path of travel and 4" maximum from walls. DSA Policy 99-08.

O. Hardware (including panic hardware) shall not be provided with "Night Latch" (NL) function for any accessible doors or gates unless the following conditions are met per DSA Interpretation 10-08 DSA/AC (External), revised 4/28/09. Such conditions must be clearly demonstrated and indicated in the specifications:
1. Such hardware has a 'dogging' feature.
2. It is dogged during the time the facility is open.
3. Such 'dogging' operation is performed only by employees as their job function (non-public use).

P. Pair of doors: limit swing of one leaf to 90 degrees so that a clear floor space is provided beyond the arc of the swing for the wall-mounted tactile sign. CBC Section 11B-703.4.2.1

2.05 FINISHES

A. Components and Fabric: Vinyl coated over coating of 1.8 oz/sq ft galvanizing (over coating of 550 g/sq m galvanizing).

B. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.

C. Accessories: Same finish as framing.

D. Color(s): Black.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

B. Place fabric on outside of posts and rails.

C. Set intermediate posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.

D. Line Post Footing Depth Below Finish Grade: ASTM F 567.

E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F 567.

F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

G. Provide top rail through line post tops and splice with 6 inch (150 mm) long rail sleeves.

H. Install center brace rail on corner gate leaves.

I. Do not stretch fabric until concrete foundation has cured 28 days.

J. Stretch fabric between terminal posts or at intervals of 100 feet (30 m) maximum, whichever is less.

K. Position bottom of fabric 2 inches (50 mm) above finished grade.
L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches (380 mm) on centers.

M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

N. Install bottom tension wire stretched taut between terminal posts.

O. Install support arms sloped inward and attach barbed wire; tension and secure.

P. Do not attach the hinged side of gate to building wall; provide gate posts.

Q. Install hardware and gate with fabric and barbed wire overhang to match fence.

R. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

S. Ground fence in accordance with Section 33 79 00.

3.02 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm).

B. Maximum Offset From True Position: 1 inch (25 mm).

C. Components shall not infringe adjacent property lines.

END OF SECTION 32 31 13
SECTION 32 31 19

TUBE STEEL FENCES AND GATES

PART1  GENERAL

1.01  SECTION INCLUDES

A. Tube steel fencing.
B. Tube steel gates.
C. Accessible gate hardware
D. Horizontal sliding gates.

1.02  RELATED REQUIREMENTS

A. Division 03 Section Cast-in-Place Concrete
B. Division 07 Section Joint Sealants
C. Division 08 Section Door Hardware
D. Division 09 Section High Performance Exterior Metal Coatings
E. Division 32 Section Architectural Site Concrete

1.03  SUBMITTALS

A. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
   1. Prepare Project specific information, drawn accurately to scale. Shop Drawings shall not be reproductions of the Contract Documents or any standard printed data.
   2. Where installed metal fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified professional engineer who was responsible for the preparation.

B. Product data in the form of manufacturer's technical data, specifications, and installation instructions for fence and gate posts, fabric, gates, hardware and accessories specified in the section.
   1. Fence and gate posts, rails, and fittings.
   2. Gates and hardware, including accessible gate lever lockset.
   3. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.04  QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has at least three years' experience and has completed at least five tube steel fence projects with same material and of similar scope to that indicated for this Project with a successful construction record of in-service performance.
B. Single-Source Responsibility: Obtain tube steel fences and gates, including accessories, fittings, and fastenings, from a single source.

1.05 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for fences and gates shown on the Drawings in relation to the property survey and existing structures. Verify dimensions by field measurements.

PART 2 PRODUCTS

2.01 TUBE STEEL FENCE

A. All parts shall be square tube steel. All posts, frames, rails, and braces parts shall be galvanized tube steel meeting the requirements of ASTM A 500 grade B.787. All other tube steel shall meet the requirements of ASTM A 513. All posts shall have a welded post cap. The following minimum sizes shall be used:

1. Minimum
   a. Item O.D. Wall Thickness
   b. Line Posts 2" or 3" 0.188"
   c. Corner Posts, Terminal Posts 4" 0.188"
   d. Pedestrian Gate Posts 4" 0.188"
   e. Vehicular Gate Posts 6" 0.188"
   f. Pedestrian Gate Rails, Frame and Braces 2" 0.188"
   g. Vehicular Gate Rails, Frame and Braces 2" 0.188"
   h. Vehicular Gate Bottom Rail 2"X4" 0.188"
   i. Pedestrian Fence Top Rail 2" 0.188"
   j. Pedestrian Fence Bottom Rail 2"X4" 0.188"
   k. Fence and Gate Pickets 3/4" 0.125"
   l. Vehicular Gate Pickets 3/4" 0.125"

B. Infill Panels: Custom design as indicated on Drawings.
   1. Perforated Metal Sheet: Uncoated steel sheet, perforated as indicated, 0.052-inch (1.52-mm) nominal thickness.

C. Steel Finish: High-performance coating.

2.02 VEHICLE GATES

A. Gates shall be located as shown on the Drawings and sized to suit existing walkways and roadways. All vehicular gates shall have a minimum clear opening of 20 feet designated for Fire Department access. Materials used shall be equal to or greater than that used in adjoining sections of fence and be compatible with the application.

B. Steel Finish: High-performance coating.

2.03 PEDESTRIAN GATES

A. Pedestrian gates shall have a ladder type frame, i.e., two vertical ends and two horizontal rails and made of steel tubing, gate pickets, provisions for locking hardware, kickplate/kickbox, drop rod and gate hardware.

B. Frame Corner Construction: Welded with an intermediate rail for panels 5 feet (1.52 m) wide or wider.

C. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for pairs of gates.
D. Steel Finish: High-performance coating.

2.04 HARDWARE

A. Pedestrian Gate Hardware: Provide galvanized hardware and accessories for each gate according to the following:

B. Accessible Latch/Lockset: Locksets shall be heavy-duty with hinged, anti-friction, 1-inch throw latchbolt with anti-friction piece made of self-lubricating stainless steel. Provide locksets with interchangeable core cylinders. Provide double cylinder, keyed to match building exterior doors. Locksets to be furnished with thru-bolted hardware to attached through gate frame, round or square post stock. Lever handles must be of forged or cast brass, bronze or stainless steel construction.
2. Locksets to be furnished with thru-bolted hardware to attached through gate frame, round or square post stock. Lever handles must be of forged or cast brass, bronze or stainless steel construction.

C. Kickplate: Smooth solid metal surface (12GA), to match frame material and finish, along the entire width of the gate, and minimum of 10” above the pedestrian surface to be provide at all accessible pedestrian gates.

D. All gate drop rod assemblies are to use a 1/2” diameter solid steel center stop. Provide a 12” steel sleeve. In asphalt areas secure sleeve in a 12” diameter by 18” deep concrete footing.

E. All non-automated vehicular and fire lane gates shall have a hold open post. Posts shall have a provision for locking the gate to the post in the open position.

F. Pedestrian Gate Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron.
3. Weld surface to attach to post or jamb
4. Size & Quantity: 5” x 1-1/4” (3 per leaf).

G. Vehicular Gate Hinges:
1. Basis-of-Design Product: The design for hinging systems is based on “Guardian Series 2000” Antech Corporation 3431 East Lind Road, Tucson, AZ 85716, (800) 866-9115, or a comparable product.
2. Weld surface to attach to post or jamb
3. Roller bearing design.
4. Zerk fitting for greasing.
5. 3/4”-inch gap when gate is opened 90 degrees.
6. Stainless steel washes and Zinc Plated bolt.
7. Size & Quantity: 4-inch by 2-inch. One pair per 1500 lbs. (3 minimum per leaf)

H. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push pad actuating bar, suitable for exterior use.
2. Function: 04 - Entrance by trim when latch bolt is released by key or set in a retracted position by key.
3. Mounting Channel: Bent-plate channel formed from 1/8-inch-(3.2-mm-) thick, steel plate. Channel spans gate frame. Exit device is
mounted on channel web, recessed between flanges, with flanges extending 1/8 inch (3.2 mm) beyond push pad surface.

I. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 1/2-inch- (12.7-mm-) diameter, round steel bars, hot-dip galvanized after fabrication, unless otherwise shown on drawings. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

J. Gate Keeper: Galvanized steel, duckbill type to auto-engage in open position and hold open. High Performance coating to match fence and gate color.

K. Gates that are part of the accessible route shall meet all the requirements of an accessible door in compliance with CBC Section 11B-404.

L. The lever of lever actuated latches or locks for an accessible gate shall be curved with a return to within 1/2" of the (face of) gate to prevent catching on the clothing or persons. California Referenced Standards code. T-24 part 12, Section 12-10-202, Item (F).

M. Swing doors and gate surfaces within 10" of the finish floor or ground shall have a smooth surface on the push side extending the full width of th door or gate. Parts creating horizontal or vertical joints in these surfaces shall be within 1/16" of the same plane as the other and be free of sharp or abrasive edges. Cavities created by added kick plates shall be capped. CBC Section 11B-404.2.10

N. The clear opening width for a door shall be 32" minimum. For a swinging doors it shall be measured between the face of the door and the stop, with the door open 90 degrees. There shall be no projections into it below 34" and 4" maximum projections into it between 34" and 80" above the finish floor or ground. Door closers and stops shall be permitted to be 78" minimum above the finish floor or ground. CBC Section 11B-404.2.3

O. Handles pulls, latches, locks, and other operable parts on accessible doors shall comply with CBC Section 11B-309.4 and shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. Operable parts of such hardware shall be 34" minimum and 44" maximum above finish floor or ground. Where sliding doors are in the fully open position, operating hardware shall be exposed and usable from both sides. CBC Section 11B-404.2.7

P. The force for pushing or pulling open a door shall be as follows: CBC Section 11B-404.2.9

1. Interior hinged doors, sliding or folding doors: 5 pounds (22.2N) maximum. Required fire doors: the minimum opening force allowable by the DSA authority, not to exceed 15 pounds (67N). These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position.

2. The force required for activating any operable parts, such as lever hardware, or disengaging other devices shall be 5 pounds (22.2 N) maximum to comply with CBC Section 11B-309.4

Q. Door closing speed shall be as follows: CBC Section 11B-404.2.8

1. Closer shall be adjusted so that the required time to move a door from an open position of 90 degrees to a position of 12 degrees from the latch is 5 seconds min.
2. Spring hinges shall be adjusted so that the required time to move a door from an open position of 70 degrees to the closed position is 1.5 seconds minimum.

R. Thresholds shall comply with CBC Section 11B-404.2.5

S. Floor stops shall not be located in the path of travel and 4” maximum from walls. DSA Policy 99-08.

T. Hardware (including panic hardware) shall not be provided with "Night Latch" (NL) function for any accessible doors or gates unless the following conditions are met per DSA Interpretation 10-08 DSA/AC (External), revised 4/28/09. Such conditions must be clearly demonstrated and indicated in the specifications:
   1. Such hardware has a 'dogging' feature.
   2. It is dogged during the time the facility is open.
   3. Such 'dogging' operation is performed only by employees as their job function (non-public use).

U. Pair of doors: limit swing of one leaf to 90 degrees so that a clear floor space is provided beyond the arc of the swing for the wall-mounted tactile sign. CBC Section 11B-703.4.2.1

2.05 HORIZONTAL SLIDE GATES

A. Gate Configuration: Single leaf.
   1. Type: Cantilever slide, with external roller assemblies.

B. Gate Frame Height: 72 inches (1830 mm).

C. Gate Opening Width: As indicated on drawings.
   1. Steel Frames and Bracing: Fabricate members from square tubing.
      [Hot-dip galvanized frames after fabrication.]
      a. Frame Members: Steel tubing 2 by 4 inches (50 by 100 mm) with 1/8-inch (3.2-mm) wall thickness.
      b. Bracing Members: Steel tubing 2 by 2 inches (50 by 50 mm) with 1/8-inch (3.2-mm) wall thickness.

D. Frame Corner Construction:
   1. Welded frame with panels assembled with bolted corner fittings.

E. Additional Rails: Provide as indicated, complying with requirements for fence rails.

F. Infill: Comply with requirements for adjacent fence.

G. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
   1. Treillage: Provide iron castings of pattern indicated between each pair of pickets. Finish as specified for adjacent fence.

H. Hardware: Latches permitting operation from both sides of gate, hangers, roller assemblies, and stops fabricated from galvanized steel.

I. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

J. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M unless otherwise indicated. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

2.06 FINISHES

A. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

B. Surface Preparation: Clean surfaces according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   1. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils (0.05 mm) per applied coat, to surfaces that will be exposed after assembly and installation, and to concealed surfaces.

   1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

E. Powder Coating: Immediately after cleaning, apply 2-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils (0.20 mm). Comply with coating manufacturer's written instructions.
   1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.07 MISCELLANEOUS MATERIALS

A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 3 Section "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387 mixed with potable water according to manufacturer's written instructions.

B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.
   1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.02 PREPARATION
A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 200 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, property monuments, property lines, and easements.

3.03 PERFORMANCE REQUIREMENTS
A. All gates shall be designed and constructed to withstand the weight of a 200 pound person standing at the mid-point on the lower rail without permanent deformation of any component members of the assembly.
B. Fabricator to provide structural calculations for each type gate verifying the performance requirements of this section.

3.04 ON THE JOB SITE
A. After the fence has been erected and is mechanically complete, wire brush field welds, dry wipe off all loose residue, spot prime with the Zinc Chromate all bare metal, bare spots and chips, and unpainted surfaces. Then spray a finish coat over the entire fence installation with one coat of industrial quality coating. Care shall be taken to keep paint off of sidewalks, wall, etc.

3.05 FABRICATION AND INSTALLATION
A. Fencing shall be welded and have smoothed, clean, slag free welds. Dimensions and installation shall be in accordance with the drawings.
B. The lever of lever actuated latches or locks for an accessible gate shall be curved with a return to within 1/2" of the (face of) gate to prevent catching on the clothing or persons. California Referenced Standards code. T-24 part 12, Section 12-10-202, Item (F).
C. Swing doors and gate surfaces within 10" of the finish floor or ground shall have a smooth surface on the push side extending the full width of the door or gate. Parts creating horizontal or vertical joints in these surfaces shall be within 1/16" of the same plane as the other and be free of sharp or abrasive edges. Cavities created by added kick plates shall be capped. CBC Section 11B-404.2.10

3.06 POST SETTING
A. General: Comply with ACI 301 for cast-in-place concrete.
1. Concrete Mixes: Normal-weight concrete with not less than 3000-psi (20.7- MPa) compressive strength (28 days), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum size aggregate.
C. All posts to be set in concrete as detailed on the drawings.
D. All posts to have concrete domed to shed water. All posts to be set to a maximum of 8 feet O.C. All post to be set plumb, in line, and to correct height. A Corner Post is required when line of fence direction changes 30 degrees or more.
E. All posts set in existing concrete slabs to be set in a 6 inch core drilled hole and set to a depth of 24 inches. All 6 inch gate posts set in existing
concrete slabs are to be set in 12 inch square saw cut to a depth of 43 inches.

3.07 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

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

3.08 GATE INSTALLATION

A. General: Install gates level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.09 SITE CLEAN UP

A. The construction site shall be cleaned up and all accumulated debris removed by the Contractor.

END OF SECTION 32 31 19
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Retaining wall system consisting of modular concrete masonry units.

B. Referenced Sections:
   1. Section 012500 - Substitution Procedures.
   2. Section 013300 - Submittal Procedures.
   4. Section 018113 - Sustainable Design Requirements.

1.02 REFERENCES

A. ASTM International (ASTM):
   3. C 331-14 - Specification for Lightweight Aggregates for Concrete Masonry Units.
   5. C 989-14 - Specifications for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.

B. American Association of State Highway & Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges, Section 5.8

C. National Concrete Masonry Association (NCMA):

1.03 DEFINITIONS

A. Structural Geogrid: A structural element formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.

B. Modular Unit: A concrete retaining wall element machine made from portland cement, water, and aggregates.
C. **Unit Fill**: Drainage aggregate which is placed within and immediately behind the modular concrete units.

D. **Reinforced Backfill**: Compacted soil which is placed within the reinforced soil volume as outlined on the plans.

### 1.04 SUBMITTALS

A. **Product Data**: In accordance with the provisions of Section 013300, submit complete manufacturer's descriptive literature and specifications.

B. **Samples**: In accordance with the provisions of Section 013300, submit the manufacturer's standard colors and finishes palette, for selection by Architect.
   1. When selection has been made, submit samples of finish not less than 8 inches by 8 inches in size for final review and acceptance.

C. **Shop Drawings**: Contractor shall submit engineering plans prepared by a professional engineer experienced with Mechanically Stabilized Earth retaining wall systems and registered in the state of the project location. The engineering designs, techniques, and material evaluations shall be in accordance with the manufacturer's published design manual, NCMA Design Guidelines For Segmental Retaining Walls, or the AASHTO Standard Specifications for Highway Bridges, Section 5.8, whichever is applicable.

D. **Quality Control Submittals**:
   1. **Deferred Design Submittals**: Construction drawings and design calculations for the retaining wall system shall be prepared by a registered professional engineer and shall bear his signature and seal. The contractor shall submit the construction drawings and design calculations to the engineer for approval prior to beginning construction.
   1. **Test and Evaluation Reports**:
      a. Contractor shall submit a test report documenting strength of specific modular concrete unit and geogrid reinforcement connection. The maximum design tensile load of the geogrid shall be equal to the laboratory tested ultimate strength of geogrid/facing unit connection at a maximum normal force limited by the "Hinge Height" of the structure divided by a safety factor of 1.5. The connection strength evaluation shall be performed in accordance with NCMA test method SRWU-1.
   2. **Certificates**:
      a. Contractor shall submit a Manufacturer's certification, prior to start of work, that the retaining wall system components meet the requirements of this specification.
         1) The contractor's submittal package shall include but not limited to actual test results for tension/creep, durability/aging, construction damage, geogrid/facing connection, pullout, and quality control.
      b. Contractor shall submit certification, prior to start of work, that the retaining wall system (modular concrete units and specific geogrid) has been successfully utilized on a minimum of five similar projects.
1.05 SUSTAINABLE DESIGN SUBMITTALS

A. Materials & Resources Submittals: Refer to Section 018113 for additional information on LEED submittals.
1. Letter Template for MR Credit 2: Letter template, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
   a. Comply with Section 017419 Construction Waste Management and Disposal.
2. Product Data and Certification Letter for MR Credit 4: Indicate percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
3. Product Data for MR Credit 5: For regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

1.06 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer's Qualifications: Contractor shall submit a list of previous projects totaling of 500,000 square feet or more where the specific retaining wall system has been used successfully. Contact names and telephone numbers shall be listed for each project.
2. Installer's Qualifications:

B. Field Samples: Provide a test panel of sandblast finish in semi-concealed location designate by Architect. Upon approval of finish, panel may serve as standard of quality for exposed work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
1. Store precast concrete units above ground on level platforms which allow air circulation under stacked units.
2. Handle units on pallets or flat bed barrows.
3. Do not permit free discharge from conveyer units.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Design is based on the use of products manufactured by one of the following:
B. Like materials shall be the products of one manufacturer and shall be either the ones upon which the design is based or the products of other manufacturers accepted in advance in accordance with Section 012500.

2.02 MODULAR UNITS

A. Modular concrete units shall conform to the following architectural requirements:
   1. Face Color: Standard manufacturers’ color or custom color as specified by the Owner.
   2. Face Finish: Sculptured rock face in angular multiplaner configuration. Other face finishes will not be allowed without written approval of owner.
   3. Bond Configuration: Running with bonds nominally located at midpoint vertically adjacent units, in both straight and curved alignments.
   4. Exposed Surfaces Of Units: Free of chips, cracks or other imperfections when viewed from a distance of 10 feet under diffused lighting.

B. Modular concrete units shall conform to the following material requirements:
   1. Cement - Materials shall conform to the following applicable specifications.
         1) Limestone: Calcium carbonate, with a minimum 85 percent content, may be added to the cement, provided these requirements of C 150 as modified are met:
            a) Limitation on Insoluble Residue: 1.5 percent.
            b) Limitation on Air Content of Mortar, by Volume: 22 percent maximum.
            c) Limitations of Loss of Ignition: 7 percent.
      d. Pozzolans: ASTM C 618.
   2. Aggregates: Aggregates shall conform to the following specifications, as applicable.
   3. Other Constituents: Air entraining agents, coloring pigments, integral water repellents, finely ground silica, and other constituents shall be previously established as suitable for use in modular concrete retaining wall units and shall conform to applicable ASTM standards or, shall be shown by test or experience to be not detrimental to the durability of the modular concrete units or any material customarily used in retaining wall construction.

C. Modular concrete units shall conform to the following structural and geometric requirements:
   1. Compressive strength: 3000 psi minimum.
2. Absorption: 8 percent maximum (6 percent in northern states) for standard weight aggregates.
3. Unit Depth: 20 inches minimum.
4. Unit Width To Height Ratio: 2.25 to 1.
5. Unit Weight: 90 pounds/unit minimum for standard weight aggregates.
6. Inter-unit Shear Strength: 1500 pounds per linear foot minimum at 2 psi normal pressure.
7. Geogrid/unit Peak Connection Strength: 1000 pounds per linear foot minimum at 2 psi normal force.
8. Maximum Horizontal Gap Between Erected Units: 1/2-inch.

D. Modular concrete units shall conform to the following constructability requirements:
1. Vertical Setback; 1/8-inch± per course (near vertical) or 1-inch± per course per the design drawings.
2. Alignment and Grid Positioning Mechanism: Fiberglass pins, two per unit minimum.

2.03 SHEAR CONNECTORS

A. Strength of shear connectors between vertical adjacent units shall be applicable over a design temperature of 10 degrees F to plus 100 degrees F. Shear connectors shall be 1/2-inch diameter thermoset isophthalic polyester resin-pultruded fiberglass reinforcement rods. Connectors shall have a minimum flexural strength of 128,000 psi and short beam shear of 6400 psi.

B. Shear connectors shall be capable of holding the geogrid in the proper design position during grid pre-tensioning and backfilling.

2.04 BASE LEVELING PAD MATERIAL

A. Material shall consist of a compacted crushed stone base or non-reinforced concrete as shown on the construction drawings. The leveling pad shall be a minimum of 6 inches thick. As an option, concrete may be 3 inches thick with a compacted granular base for a total thickness of 6 inches.

2.05 UNIT FILL

A. Unit fill shall consist of clean 1-inch minus crushed stone or crushed gravel meeting the gradation listed below:

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>PERCENT PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>75 - 100</td>
</tr>
<tr>
<td>No. 4</td>
<td>0 - 10</td>
</tr>
<tr>
<td>No. 50</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>
B. One cubic foot, minimum, of drain fill shall be used for each square foot of wall face. Drain fill shall be placed within cores of, between, and behind units to meet this requirement.

2.06 REINFORCED BACKFILL

A. Reinforced backfill shall be free of debris and meet the following gradation requirements:

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>PERCENT PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-inches</td>
<td>100 - 75</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>75 - 100</td>
</tr>
<tr>
<td>No. 4</td>
<td>100 - 20</td>
</tr>
<tr>
<td>No. 40</td>
<td>0 - 60</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 35</td>
</tr>
</tbody>
</table>

Plasticity Index (PI) <10 and liquid limit <40

B. The maximum aggregate size shall be limited to 3/4-inch unless field tests have been or will be performed to evaluate potential strength reductions to the geogrid design due to damage during construction.

C. Material can be site excavated soils where the above requirements can be met. Unsuitable soils for backfill (high plastic clays or organic soils) shall not be used in the backfill or in the reinforced soil mass.

D. Contractor shall submit reinforced fill sample and laboratory test results to the Architect/Engineer for approval prior to the use of any proposed reinforced fill material.

2.07 GEOGRID

A. Creep Limited Tensile Load:
   1. \( T_{cr} \) shall be determined from 10,000-hour creep testing performed in accordance with ASTM D 5262.

B. Allowable Tensile Design Load, shall be determined as follows:
   1. \( T_a = \frac{T_{cr}}{(FD*FC*FS)} \)
   2. \( T_a \) shall be evaluated based on a 75-year design life.

C. Factor for Durability/Aging;
   1. \( FD \) shall be determined from polymer specific durability testing covering the range of expected soil environments.

D. Factor for Construction Damage;
   1. \( FC \) shall be determined from product specific construction damage testing performed in accordance with GRI-GG4. Test results shall be provided for each product to be used with project specific or more severe soil type.

E. Overall Factor of Safety:
   1. \( FS \) shall be 1.5 unless otherwise noted.
F. The maximum design tensile load of the geogrid shall not exceed the laboratory tested ultimate strength of the geogrid/facing unit connection as limited by the "Hinge Height" divided by a factor of safety of 1.5. The connection strength testing and computation procedures shall be in accordance with NCMA test methods.

G. Soil Interaction Coefficient:
1. $C_i$ values shall be determined per GRI:GG5 at a maximum 0.75-inch displacement.

H. Manufacturing Quality Control: The geogrid manufacturer shall have a manufacturing quality control program that includes QC testing for each 40,000 SF of production, each lot, or each production day. The QC testing shall include:
1. Tensile Modulus.
2. Specific Gravity.
4. Molecular Weight (PETP).

PART 3 - EXECUTION

3.01 EXCAVATION
A. Contractor shall excavate to the lines and grades shown on the construction drawings. Architect/Engineer will inspect the excavation and approve prior to placement of leveling material or fill soils.

B. Over-excavation of deleterious soils and replacement with suitable fill will be paid at unit cost rates.

3.02 BASE LEVELING PAD
A. Leveling pad materials) shall be placed to the lines and grades shown on the construction drawings, to a minimum thickness of 6 inches.

B. Soil leveling pad materials shall be compacted to a minimum of 95 percent standard or 90 percent modified Proctor.

C. Leveling pad shall be prepared to insure full contact to the base surface of the concrete units.

3.03 INSTALLATION - MODULAR CONCRETE UNITS
A. First course of units shall be placed on the leveling pad, and alignment and level checked. Pins or molded surfaces of modular concrete units shall be used for alignment control.

B. Position vertically adjacent modular concrete units as recommended by the Manufacturer.

C. Maximum stacked vertical height of wall units, prior to wall drain fill and backfill placement and compaction, shall not exceed two courses.

D. Whole, or cut, units on curves and corners to shall be erected with running bond approximately centered on units above and below.

E. Cap units shall be glued to underlaying units with an adhesive recommended by the manufacturer.
3.04 INSTALLATION - STRUCTURAL GEOGRID

A. Geogrid shall be oriented with the highest strength axis perpendicular to the wall alignment.

B. Geogrid reinforcement shall be placed at the elevations and to the extent shown on the construction drawings or as directed by the Engineer.

C. The geogrid shall be laid horizontally on compacted backfill. Place the next course of modular concrete units over geogrid. The geogrid shall be pulled taut, and anchored prior to backfill placement on the geogrid.

D. Geogrid reinforcements shall be continuous throughout their embedment lengths. Spliced connections between shorter pieces of geogrid is not allowed unless pre-approved by the Architect/Engineer prior to construction.

3.05 REINFORCED BACKFILL PLACEMENT

A. Reinforced backfill shall be placed, spread, and compacted in such a manner that minimizes the development of slack in the geogrid.

B. Reinforced backfill shall be placed and compacted in lifts not to exceed 8 inches where hand compaction is used, or 12 inches where heavy compaction equipment is used.

C. Reinforced backfill shall be compacted to 95 percent of the maximum density as determined by ASTM D 695. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer and shall be within 2 percentage points dry of optimum.

D. Only lightweight hand-operated equipment shall be allowed within 3 feet from the tail of the modular concrete unit.

E. Tracked construction equipment shall not be operated directly upon the geogrid reinforcement. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Tracked vehicle turning should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.

F. Rubber tired equipment may pass over geogrid reinforcement at slow speeds, less than 10 MPH. Sudden braking and sharp turning shall be avoided.

G. At the end of each day's operation, the Contractor shall slope the last lift of reinforced backfill away from the wall units to direct runoff away from wall face. The Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

END OF SECTION
SECTION 32 33 00

SITE FURNISHINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Benches.
B. Bollards.
C. Tables.
D. Waste receptacles.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Bollard infill and underground encasement.
B. Section 05 50 00 - Metal Fabrications: Anchors to attach site furnishings to mounting surfaces.

1.03 REFERENCE STANDARDS

D. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer’s specifications and descriptive literature, installation instructions, and maintenance information.
C. Samples: Submit two sets of manufacturer’s available colors and finishes for precast furnishings.

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide manufacturer’s Lifetime Warranty against defects in materials or workmanship for wood benches manufactured from solid teak.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Furnishings:

B. Steel Pipe Bollards:

C. Wood Furnishings:
   1. Landscape Forms Site Furnishings; [Multiplicity Picnic Table]: www.LandscapeForms.com.

2.02 METAL FURNISHINGS

A. Metal Furnishings, General:
   1. Cast iron components: Ductile iron castings complying with ASTM A536; cleaned, treated, and powder-coated.
      a. Color: As shown on drawings.
   2. Steel components: Plates, bars, and shapes complying with ASTM A36/A36M and tubing complying with ASTM A500/A500M; cleaned, treated, and powder-coated.
      a. Color: As shown on drawings.
   3. Wood components: Ipe with eased edges, and clear wood preservative coating.
   4. Recycled plastic lumber (RPL) components:
      a. Color: As shown on drawings.

B. Waste Receptacles: Steel frame with steel slats and removable lid.
   1. Capacity: 20 gallons (76 liters).
   2. Shape: Round.
   3. Lids:
      a. Material: Steel.
      b. Type: Flat.

2.03 WOOD BENCHES

A. Materials:
   2. Factory Finish: Natural.

B. Benches: Solid metal supports and wooden seat section without back.
   1. Shape: Rectangle.
   2. Length: [Per plan].
   3. Width: [ ].

2.04 BOLLARDS

A. Steel Pipe Bollards: Hollow steel pipe with plain shaft.
   1. Shape: Round.
   2. Diameter: [8”].
   3. Materials:
      b. Factory Finish: Primed and with Night Reflectors
      c. Color: As selected by Architect from manufacturer’s standard range.
   4. Mounting: In-ground.
   5. Products:
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that mounting surfaces, preinstalled anchor bolts, or other mounting devices are properly installed; and ready to receive site furnishing items.

3.02 INSTALLATION
   A. Install site furnishings in accordance with approved shop drawings, and manufacturer's installation instructions.
   B. Provide level mounting surfaces for site furnishing items.

END OF SECTION 32 33 00
SITE FURNISHINGS
32 33 00 - 4
ARCHITECTURAL SITE CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES
   A. Concrete site walls.
   B. Concrete retaining walls.
   C. Concrete cheek walls for exterior concrete stairs.
   D. Concrete benches.
   E. Concrete planters.
   F. Skateboard deterrents.
   G. Light pole bases.
   H. Other architectural site concrete as indicated.

1.02 RELATED REQUIREMENTS
   A. Division 07 Section - Joint Sealants
   B. Division 09 Section - Permanent Non-Sacrificial Anti-Graffiti
   C. Division 32 Section - Concrete Paving
   D. Division 32 Section - Concrete Paving Joint Sealants

1.03 DEFINITIONS
   A. Cast-in-Place Architectural Site Concrete: Non-building formed concrete that is exposed to view in completed exterior work and that requires concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
   B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: Fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
   D. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

1.04 PREINSTALLATION MEETINGS
   A. Pre-installation Conference: Conduct conference at project site.
      1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place architectural site concrete to attend, including the following:
         a. Contractor's superintendent.
         b. Independent testing agency responsible for concrete design mixtures.
1. District's Representative(s).
2. Ready-mix concrete manufacturer.
3. Architect's Representative(s).
5. Inspector of Record (IOR).
6. Subcontractor for any adjacent work.

2. Review testing and inspection procedures, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural site concrete.

3. Contractor to provide meeting minutes for pre-installation conference.

1.05 SUBMITTALS

A. Product Data: For each type of product.
   1. Proprietary admixtures, pigments, curing compounds, hardeners, sealers, form-release agents, all accessory material, etc.: Indicate compatibility with other materials used.

B. Samples for Initial Selection: For each type of product, ingredient or admixture requiring color selection.
   1. Submit manufacturer selected range of colors and products for review.
   2. Provide custom colors or samples as required.
   3. Upon selection of color submit 12"X12" sample of material in the specified color/finish for review by the Landscape Architect in addition to the specified mock-ups.

C. LEED Submittals:
   1. Product Data for Credit MR 4.1 [and Credit MR 4.2]: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing at least 40% fly ash as a replacement for Portland cement or other Portland cement replacements and for equivalent concrete mixtures that do not contain Portland cement replacements.

D. Design Mixtures: Submit proposed mix designs and test data for each class, color, application, and strength of concrete and for each method of placement.
   1. Prepare mix designs on the basis of field experience (preferred) and/or trial mixes, in compliance with California Building Code (CBC), Section 1905A.3.
   2. Prepare mix designs on the basis of field experience (preferred) and/or trial mixes, in compliance with California Building Code (CBC), Section 1905.3.
   3. Mix designs shall be prepared and signed by a structural or civil engineer registered in the State of California.
      a. Mix designs shall be reviewed by the Architect and Structural Engineer of Record (SEOR).
   4. Identify for each mix design submitted the method by which proportions have been selected.
      a. For mix designs based on field experience, include individual strength test results, standard deviation, and required average compressive strength calculations.
b. For mix designs based on trial mixtures, include trial mix proportions, test results, graphical analysis and show required average compressive strength face results. Provide gross weight and yield per cubic yard of trial mixes.

c. Indicate quantity of each ingredient per cubic yard of concrete.

d. Indicate type and quantity of admixtures proposed or required.

e. Indicate water to cement ratio by weight.

f. Measured slump.

g. Measured air content.

h. Provide shrinkage test results.

i. Provide maximum [5%] fly ash; ground granulated blast-furnace slag, and/or silica fume content as Portland cement replacement in all concrete.

j. [no fly ash will be permitted]

5. Submit proposed alternate design mixtures for review by the Architect [and SEOR] when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

6. Mix designs for each application must be from a single source for the duration of the project. Multiple vendors or courses will not be permitted.

7. All mix designs must be wet stamped by a licensed Structural Engineer.

E. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1. Coordinate with and identify the details of the Contract Drawings on the shop drawings.

2. Comply with ACI 315, part B and CRSI requirements.

F. Formwork Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural site concrete.

1. Engineering Responsibility: Formwork shop drawings shall be prepared by or under the supervision of a licensed professional engineer detailing fabrication, assembly, and support of formwork.

2. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

3. Location of form ties and patterns are subject to approval of the Landscape Architect. For walls less than 18” high, ties to be located above and below wall face, whenever possible.

4. Align all form joints with reveal locations indicated on plans. Provide custom size and cut form boards as required.

G. Construction Joint Layout: Indicate proposed construction joints required to construct the structure. Submit dimensioned drawing indicating layout of construction joints, contraction (control) joints, dowelled joints, decorative scoring and placement sequence of concrete.

1. Location of construction joints are subject to approval of the Architect.

2. Construction joints locations should align with reveal locations as located per drawings.
3. Provide custom form boards as required for joint alignment noted per drawings.
4. Align all form joints with reveal locations indicated on plans. Provide custom size and cut form boards as required.

H. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.

I. Samples: For each of the following materials:
   1. Form-facing panel.
   2. Form ties.
   3. Form liners.
   5. [Chamfers and rustications.]
   6. Reveals
   7. One-half c.f. sample of sand and fine aggregate
   8. On-half c.f. sample of coarse aggregate

J. Samples for Verification: Architectural site concrete Samples, cast vertically, approximately 18” by 18” by 2 inches (450 by 450 by 50 mm), of each finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

K. Qualification Data: For manufacturer (batch plant).

L. Welding Certificates: Submit certifications signed by AWS Certified Welding Inspector of prequalified welding procedures, qualifications of welding procedures unless prequalified, qualifications of welding operators and qualifications of welders.

M. Material Certificates: For each of the following:
   1. Cementations materials.
   2. Aggregates and sand.
   3. Admixtures.
   5. Steel reinforcement and accessories.
      a. Provide mill test certificates for all reinforcing steel, showing physical and chemical analyses. For steel that will be welded, include in the chemical analysis the percentages of carbon, manganese, copper, nickel, chromium, phosphorus and sulfur, and optionally, the percentages of molybdenum and vanadium.
   6. Curing compounds.
   7. Surface treatments.
   10. Semi rigid joint filler.
   12. Repair materials.

N. Material Test Reports: For the following, by a qualified testing agency:
   1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

O. Field Quality-control Reports. Submit reports of all compressive strength, slump, shrinkage and air content tests required by the authorities having jurisdiction and as indicated.
1. Submit copies of delivery tickets complying with ASTM C 94 for each load of concrete delivered to the site. Tickets shall include all information required by the referenced standard.

P. Minutes of pre-installation conference.

1.06 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with CBC Chapter 19A.

1. Chemical products field-applied to concrete shall comply with the air quality requirements of authorities having jurisdiction.

B. Industry Standards: Comply with the following unless modified by requirements in the Contract Documents.

1. ACI 301, "Specifications for Structural Concrete".
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".
3. ACI 302.1R, "Guide for Concrete Floor and Slab Construction".
4. ACI 303.1 "Specifications for Cast-in-Place Architectural Concrete".
5. ACI 304R, "Guide for Measuring, Mixing, Transporting, and Placing Concrete".
6. ACI 305R, "Hot Weather Concreting".
8. ACI 318, "Building Code Requirements for Structural Concrete".
9. ACI 347, "Guide to Formwork for Concrete".
10. ACI 318, "Building Code Requirements for Structural Concrete."
11. ACI SP-66, "ACI Detailing Manual".
12. CRSI, "Manual of Standard Practice".
13. CRSI, "Placing Reinforcing Bars".

C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "NRMCA Quality Control Manual - Section 3, Certification of Ready Mixed Concrete Production Facilities."
2. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
3. 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.
4. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations for Cast-in-Place Architectural Site Concrete: Obtain each color, size, type, and variety of concrete material and concrete mixture from single manufacturer with resources to provide cast-in-place architectural site concrete of consistent quality in appearance and physical properties for the duration of the project.

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete,"[Sections 1 through 5.] [Sections 1 through 5 and Section 6, "Architectural Concrete."]
2. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."
F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Source Limitations for Concrete Paving: Obtain each color, size, type, and variety of concrete material and concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties. Secure all material required for the duration of the project as needed to ensure consistent quality in appearance.

H. Welding Qualifications: Comply with CBC Chapter 17A.
   1. Qualify welding procedures and welding personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel" prior to performing any welding.
   2. Qualify welding inspection personnel according to AWS QC1, "Standard for AWS Certification of Welding Inspectors."

I. Welding Qualifications: Comply with CBC Chapter 17.
   1. Qualify welding procedures and welding personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel" prior to performing any welding.
   2. Qualify welding inspection personnel according to AWS QC1, "Standard for AWS Certification of Welding Inspectors."

J. Mockups: Before casting architectural site concrete, build mockups to verify selections made under Sample submittals and to fully demonstrate typical joints, surface finish, texture, tolerances, reveals edges, bulkhead or cold joints, standard of workmanship and completed product. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
   2. Build mockups full-size, matching architectural site concrete components indicated on the Drawings. Mock-ups shall be complete in every detail, including joints, reveals, chamfers, etc. Include complex joinery conditions where necessary to integrate to other Project components as indicated.
   3. Maintain accurate records of variables associated with each mockup to facilitate the matching of accepted mockups during actual construction.
   4. Demonstrate curing, cleaning, and protecting of cast-in-place architectural site concrete, finishes, and contraction and expansion joints, as applicable.
   5. Required Mockup Types:
      a. Walls: Construct at least 6 linear feet by 4 foot by 12” wide height of finished concrete site walls for each color, finish, and mix design.
      b. Benches and Seats: Construct at least 6 linear feet of finished concrete site benches and seats.
      c. Planters: Construct at least 6 linear feet by 18” height by 12” wide of finished concrete site planters.
      d. Amphitheaters and Steps: Construct at least 6 linear feet of finished concrete steps/amphitheaters by 3 risers minimum.
      e. Abrasive-Blast Finishes: Mockups shall clearly demonstrate 3 levels of depth-of-cut for abrasive-blast finishes for Architect's review.
      f. Repairs: In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie
holes, honeycombing, spalls, surface blemishes, etc. to match adjacent undamaged surfaces.

   a. The Architect may reject mockups that, in the Architect's sole judgment, do not demonstrate an acceptable completed product, including, but not limited to, color, joint work, surface finish, texture, tolerances, and standard of workmanship.
   b. The Architect may require modifications to mockups to obtain acceptable results.
   c. The Architect may require modifications to mockup repairs to obtain acceptable results.
   d. The Architect may require removal and reconstruction of mockups to obtain acceptable results. Multiple mockups may be required.
   e. Contractor shall provide additional mockups as required to obtain results acceptable to the Architect at no additional cost to the Owner.

7. Mockup Disposition: Accepted mockups shall not become part of the completed Project. Maintain mock-up on-site for the duration of construction and until all work has been accepted. Remove and legally dispose mockups after acceptance of final installed work. If sufficient permanent architectural site work has been completed, Contractor may submit a written request to Architect to transfer quality control for architectural site concrete from the accepted mockups to one or more designated portions of the permanent work.

1.07 PROJECT CONDITIONS:
   
   A. Traffic Control: Maintain access for Owner's operations and for vehicular and pedestrian control required for construction activities.

1.08 DELIVERY, STORAGE, AND HANDLING
   
   A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
      1. Label bundles with durable identification tags. Maintain reinforcement identification after bundles are broken.
      2. Store reinforcement to avoid excessive rusting or fouling with grease, oil, dirt or other bond-weakening contaminants.
      3. Avoid damaging applied coatings, if any, on steel reinforcement.

PART 2 - PRODUCTS

2.01 FORM-FACING MATERIALS
   
   A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for formwork and other form-facing material requirements.
   
   B. Form-Facing Panels for As-Cast or Exposed-Aggregate Finishes: Steel, glass-fiber-reinforced plastic, or other approved no absorptive panel materials that will provide continuous, true, and smooth architectural site concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

   C. Form-Facing Panels for all exposed As-Cast and Exposed-Aggregate Concrete Finishes: Provide steel, glass-fiber-reinforced plastic, or overlain exterior-grade plywood panels, no absorptive, that will provide continuous, true, and smooth architectural site concrete surfaces, with no wood grain, honeycombing or patch transfer.
1. Faced plywood panels shall comply with, or be equivalent to, DOC PS 1, Structural I. Provide minimum 7-ply plywood and provide balance sheets for panels coated one-side only. Furnish in largest practicable sizes to minimize number of joints.
   a. High Gloss As-Cast Finish: Phenolic Film Overlay (PFS). Provide one of the following panels, or comparable substituted product:
      1) Olympic Panel Products, "Barrier Film Concrete Form." Overlay Color: White.
      2) Pacific Laminate Products, "ProFace PFS." Overlay Color: Tan
   b. Smooth As-Cast Finish: High-Density Overlay (HDO). Provide one of the following panels, or comparable substituted product:
      1) Olympic Panel Products, "Multipour Concrete Form." Overlay Color: Buff.
   c. Matte As-Cast Finish: Medium-Density Overlay (MDO), with mill-applied release agent and edge sealant. Provide one of the following panels, or comparable substituted product:
      1) Olympic Panel Products, "B-Matte 333 MDO Concrete Form." Overlay Color: Brown.
      2) Pacific Laminate Products, "ProFace MDO." Overlay Color: Black.

2. Curved Work: Kerf back of plywood form-facing panels, or use accepted flexible or curved forms for curved work with a radius of 100 feet or less to match finish provided by form material noted in items 1 and 2 above.

D. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will provide surfaces without gradual or abrupt irregularities that exceed specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation. Finished work is to be free of seams or form markings.

E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

F. Form Liners: Units of face design, texture, arrangement, and configuration indicated. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.

G. Rustication Strips or Reveals: Wood, metal or rigid plastic, with sides beveled and back kerfed; nonstaining; in longest practicable lengths. Align reveals as shown on plans and with form seams.

H. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800, "Specification 810.1, Expanded Cellular Glazing Tape"; minimum 1/4 inch (6 mm) thick.

I. Form Joint Sealant: Urethane or silicone elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS that adheres to form joint substrates. Form joint sealant shall be compatible with form-facing panels.
J. Form Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood. Form sealer shall be compatible with form-facing panels. All seams and joints are to be sealed.

K. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural site concrete surfaces and will not impair subsequent treatments of those surfaces. Form-release agent shall be compatible with form-facing panels.
1. Obtain written acceptance of form release agent from integral colored concrete pigment manufacturer.
2. Form-release agents shall be non-staining.

L. Surface Retarder (In Form): Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
1. Provide W. R. Grace "Euro-Tard" or accepted comparable substitute.

M. Surface Retarder (Top Surface): Chemical liquid set retarder, for application on top surface of formed applications to match finish at formed faces, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
1. Provide W. R. Grace "Top-Cast" or accepted comparable substitute.

N. Form Ties: Factory-fabricated, stainless steel or fiberglass color keyed to wall color snap ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish ties with tapered plastic tie cone spreaders that, when removed, will leave holes 3/4 inch in diameter on concrete surface.
2. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm) after exposing aggregate, from the architectural site concrete surface.
3. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) in diameter, of color selected by Architect from manufacturer's full range.
4. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.

O. Provide new forms specifically purchased for this project. Reuse of forms from past projects or contractors stock will not be accepted.

P. Provide custom form boards as required to align seams with reveals indicted on plans.

2.02 STEEL REINFORCEMENT AND ACCESSORIES

A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 60 percent.

C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed, unless otherwise indicated.

D. Low-Alloy-Steel Reinforcing Bars (for Welding): ASTM A 706/A 706M, Grade 60, deformed, unless otherwise indicated.
E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI's "Manual of Standard Practice."
1. Where legs of wire bar supports contact forms, use CRSI Class 2, stainless-steel bar supports.

F. Tie Wire: Minimum 16 ga. annealed wire, black, galvanized or coated finish to match rebar.

2.03 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 II, or Type IV, gray, unless white cement is required to achieve colors indicated. Supplement with the following:

B. Normal-Weight Aggregates: ASTM C 33, [Class 5S] [Class 5M] [Class 1N] coarse aggregate or better, graded. Provide aggregates from single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials).

C. Normal-Weight Aggregates: ASTM C 33, complying with building code.
Provide aggregates from a single source. All aggregates shall be free of materials with deleterious reactivity to alkali in cement when tested in accordance with ASTM C 289.
1. Comply with CBC section 1903A.3.
2. Comply with CBC section 1903.3.
   a. Service Class, based on CBC Figure 1904A.2.2, "Weathering Probability Map":
   b. Severe and Moderate: Class 5S.
   c. Negligible: Class 2N.
3. Maximum Coarse-Aggregate Size: [3/8] [1/2][3/4] inch nominal. Maximum size shall also not be larger than 1/4 of the narrowest dimension between forms, 1/3 the depth of slab nor more than 3/4 of the minimum clear spacing between individual reinforcing bars.
   b. Source: Reliance, San Gabriel, or Carroll Canyon

D. Normal-Weight Fine Aggregate: ASTM C 33 or ASTM C 144, manufactured or natural sand, from same source for Project, free of materials with deleterious reactivity to alkali in cement and free of materials which may cause staining and light in color
1. Source: Reliance, Fosters or Corona.
2. Color to be white to light with no dark material.

E. Water: Potable, complying with ASTM C 94/C 94M except free of wash water from mixer washout operations.

2.04 ADMIXTURES

A. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

B. Shrinkage-Reducing Admixture: Commercially formulated, shrinkage inhibitor capable of reducing initial shrinkage by 80% and long-term shrinkage by 50%. Provide product suitable for use with either air-entrained or non-air-entrained concrete as appropriate to structural member and project location.
1. Products: Subject to compliance with requirements, provide one of the following (as required):
   a. Euclid Chemical Company (The), an RPM company; EUCON SRA, SRA+.
   c. Sika Corporation; Control 40.

C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Davis Colors.
   b. L.M. Scofield Company.
   c. Solomon Colors.

2. Color: As specified on approved plans. Selected by Architect from manufacturer’s full range.

2.05 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Clear, Waterborne (Non-Colored Concrete): Provide products complying with ASTM C 309, Type 1, Class B, 18 to 25 percent solids, certified by curing compound manufacturer to not interfere with bonding of sealers, with no glossy finish and compatible with specified sealer. Provide products with not more than 100g/L volatile organic content.
1. Products: Subject to compliance with requirements.

D. Clear, Waterborne (Colored Concrete): Provide products that are acceptable to concrete color pigment manufacturer complying with ASTM C 309, Type 1, Class B, 18 to 25 percent solids, certified by curing compound manufacturer to not interfere with bonding of sealers with no glossy finish and compatible with specified sealer. Provide products with not more than 100g/L volatile organic content.
1. Products: Subject to compliance with requirements.

E. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
1. For integrally colored concrete, curing compound shall be approved by color pigment manufacturer.
2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2.06 SEALERS AND WATER REPELLENTS

A. Penetrating Liquid Floor and Horizontal Surface Treatment (Sealer): Clear, chemically reactive, water-based lithium quartz water-based lithium materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces. Materials shall be compatible with concrete admixtures and shall be recommended by manufacturer for intended use. Provide products with 0g/L volatile organic content.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Sinak Corporation; Concrete Sealer HLQ 125.

B. Penetrating Liquid Wall and Vertical Surface Treatment (Repellent): Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces. Materials shall be compatible with concrete admixtures and shall be recommended by manufacturer for intended use. Provide products with less than 100g/L volatile organic content.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. L&M Construction Chemicals, Inc.; Hydropel WB
      b. ProSoCo Inc.; SL100 Water Repellent
      c. Rainguard International; Microseal(For use with VandlGuard TEN Anti-graffiti coating)

2.07 ANTI-GRAFFITI COATING

A. Refer to Section 099620 Permanent Non-Sacrificial Anti-Graffiti Coating for product and specific sealer.

2.08 JOINT DEVICES, FILLER MATERIALS AND OTHER ACCESSORY PRODUCTS

A. Joint Filler at Exterior Sealed Joints: ASTM D 1751
   1. Lightweight, nonstaining, polyethylene closed cell expansion joint filler
   2. Exterior Expansion- and Isolation-Joint-Filler Strips: See Division 32 Section "Concrete Paving Joint Sealants" for sealants for exterior joints at concrete pavements.

2.09 REPAIR MATERIALS

A. General: Provide cementitious materials, coarse aggregates, fine aggregates, water, bonding agents and admixtures as required to prepare repair grouts that will match as-cast and site finished architectural site concrete.
   1. Maintain accurate records of repair materials and mixtures used on accepted mockups.

B. Bonding Agent: ASTM C 1059, Type II, non-re-emulsifiable. Provide proprietary products composed of latex polymers.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Grace Construction Products, W. R. Grace & Co.; "Daraweld C".
      c. Larsen Products Corp., "Weld-Crete".
2. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.

3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete and for anchoring dowels to hardened concrete.

2.10 SKATEBOARD DETERRENTS

A. General: Provide the following skateboard deterrents, unless otherwise indicated.

1. Basis of Design Product: Subject to compliance with the requirements, provide the following, or comparable substituted product:
      1) [Model FA 135, to match 3/4" chamfered edge.]
      2) [Model FR 0.12 to match 1/8" radiused edge]

2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of cast-in-place architectural site concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.

2. Proportioning:
   a. The proportioning of ingredients shall be such that the concrete can be readily worked into forms and around reinforcement under the conditions of placement to be used, without segregation or excessive bleeding.
   b. When proportioning by weight of loose, dry material, 94 pounds of cement shall be considered 1 cubic foot.
   c. Fine aggregate volume shall be at least 35 percent, with a maximum of 50 percent, of the sum of the separate fine and coarse aggregate volumes.
   d. Total water content shall not exceed 35 gallons per cubic yard of concrete.
   e. Weighing equipment shall be accurate within 1 pound and shall be adjustable for varying aggregate moisture content.
   f. A beam auxiliary shall register any part of the last 100 pounds of each aggregate. The aggregate hopper shall have a volume adjustment.

3. Prepare compressive strength data for both 7-day and 28-day strengths.
   a. The 7-day compressive strength shall be at least 60 percent of the required 28-day strength.
   b. The 28-day compressive strength shall be as indicated.

4. Provide drying shrinkage test data at 28 days, from not less than 3 test specimens.

B. Cementitious Materials-General: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not more than 5 percent. Per ACI 301 limits for concrete exposed to de-icing chemicals, limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
1. **Cementitious Materials-LEED Supplemental:** For LEED-NC Credit ID 1.1: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent. Per ACI 301 limits for concrete exposed to de-icing chemicals, limit percentage, by weight, of cementitious materials other than Portland cement in concrete as indicated above.

C. **Proportion concrete mixtures as follows:**
   1. **Minimum Compressive Strength (28 Days):** 3000 psi.
      a. Provide the following minimum compressive strength (28 days) where required by high-pressure water or bush hammer finishing techniques: 4500 psi.
   2. **Maximum Water-Cementitious Materials Ratio:** 0.50-0.60.
   3. **Slump Limit:** 4 inches, plus or minus 1 inch, unless indicated otherwise.
   4. **Slump Limit (High-Range Water-reducing Admixture):** 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture, plus or minus 1 inch, unless indicated otherwise.
   5. **Slump Limit (Plasticizing Admixture):** 8 inches for concrete with verified slump of 2 to 4 inches before adding plasticizing admixture, plus or minus 1 inch, if required/unless indicated otherwise.

D. **Slump Limit:** [4 inches (100 mm)] [8 inches (200 mm)] for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm), unless otherwise indicated.

E. **Cementitious Materials:** For cast-in-place architectural site concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 requirements.[ Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent.]
   1. Limit water-soluble, chloride-ion content in hardened concrete to [0.06] [0.15] [0.30] [1.00] percent by weight of cement.

F. **Admixtures:** Use admixtures according to manufacturer's written instructions.
   1. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement. Limit total chloride-ion content in hardened concrete to 0.10 percent by weight of concrete when tested per AASHTO T 260 potentiometric titration.
   2. Limit "drying shrinkage" after 28 days of curing hardened concrete to 0.045 percent of the original concrete volume.
   3. **Admixtures:** Admixtures may only be used if they are incorporated into the accepted concrete mix designs. Use admixtures according to manufacturer’s written instructions.
      a. Use [water-reducing] [high-range water-reducing] [or] [plasticizing] admixture in concrete, as required, for placement and workability.
      b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
      c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete.
required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

d. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

G. Color Pigment: Add color pigment to concrete mixture according to manufacturer’s written instructions and to result in hardened concrete color consistent with accepted mockup.

2.12 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI’s "Manual of Standard Practice."
   1. Splices: Do not splice bars, unless indicated on the Drawings.
   2. Staggered Splices: Stagger splices such that not more than one-half of the reinforcing bars are spliced at any location.

2.13 CONCRETE MIXING

A. Ready-Mixed Architectural Site Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M [and ASTM C 1116/1116M] and furnish batch ticket information.
   1. Clean equipment used to mix and deliver cast-in-place architectural site concrete to prevent contamination from other concrete.
   2. When air temperature is between 85 and 90 deg. F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg. F, reduce mixing and delivery time to 60 minutes.
   3. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   4. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
   5. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 60 seconds for each additional 1 cu. yd. (0.76 cu. m).
   6. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

B. Integral Colored Concrete Mixes: Add pigments at the concrete batch plant. Minimum batch size shall be three (3) yards. The same brand of cement, source of sand, and water/cement ratio shall be maintained for each load of the same color for the duration of the project.
   1. Batching Procedure: Before adding color-conditioning admixture, the mixing drum shall be thoroughly cleaned and wetted with approximately 40 gallons of the mix water and/or a portion of the aggregates. After cleaning and wetting of the drum, add the specified quantity of admixture correctly packaged for the mix design and batch quantity. Proceed with normal batching of balance of ingredients. After loading is complete, mix at mixing speed for a minimum of 15 minutes. Do not add water after a portion of the load has been discharged.

PART 3 - EXECUTION

3.01 FORMWORK

A. General: Comply with the following, unless otherwise indicated:
1. Conform to ACI 318, ACI 347 and CBC Section 1906.
2. Conform to ACI 318, ACI 347 and CBC Section 1906A.

B. Structural Loads: Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

C. Geometry: Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117. Provide for necessary openings, inserts, anchorages, and other features indicated or required. Properly locate all elements.
1. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
   a. Class A, 1/16 or 1/8 inch for smooth-formed finished surfaces.
   b. Class B, 1/4 inch (6 mm) for rough-formed finished surfaces.

D. Form Joints: Minimize form joints and make forms watertight to prevent leakage of concrete mortar. Locate form joints at exposed concrete symmetrically about center of panel and aligned with reveals, unless otherwise indicated. Align joints symmetrically at exposed conditions.
1. Seal penetrations at form ties with form joint sealant to prevent cement paste leakage.
2. Provide custom form boards as required to align with reveals.

E. Removal: Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where dismantling or stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Chamfers: Chamfered edges are not allowed. [Provide chamfered edges and corners at all exposed locations, and at all locations scheduled to receive waterproofing, unless otherwise indicated.]

3.02 CONSTRUCTED FORMWORK

A. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

B. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

C. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

D. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

E. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

F. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
G. Provide bracing and shores to ensure stability of formwork and accommodate all loads. Use form ties of sufficient strength and in sufficient quantities to prevent formwork spreading. Maintain principal shores to support concrete until required strength is achieved.

3.03 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install embedded accessories level, true-to-line and plumb in accordance with manufacturer's instructions.
   2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
   3. Provide reveals around embedded items such as light fixtures as shown on Drawings.

3.04 OPENINGS, DEPRESSIONS, RECESES AND CHASES

A. Size and locate formed openings, depressions, recesses and chases to accommodate products to be applied to, built-into and/or pass-through concrete Work. Coordinate size, location and placement of inserts, embedded products, openings and recesses with Work of other sections. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.05 FORM RELEASE AGENTS

A. General: Provide either form materials with factory-applied non-absorptive liner or field-applied form coating. Field-applied coating shall be non-staining.
   1. Non-absorptive Liner: Rust on steel form surfaces is not acceptable.
      a. Reapply coating to thoroughly cleaned and reconditioned formwork before each use.
      b. Verify compatibility of release agents with integrally-colored concrete and all subsequently applied curing compounds, coatings, applied finishes, etc. Do not apply release agent if items are non-compatible.
      c. Do not apply release agent where decorative wood graining is intended for concrete surface. Leave form face dry.

3.06 CONCRETE SURFACE RETARDERS

A. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.

3.07 FORM LINERS

A. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form
liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

3.08 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg. F for 72 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
   1. Schedule form removal to maintain surface appearance that matches accepted mockups.
   2. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved its 28-day design compressive strength, but not less than 21 days after pour.
   3. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
   4. All formwork is to be new specifically purchased for this project.

B. Clean and repair surfaces of forms to be reused in the Work in non-exposed areas. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.09 STEEL REINFORCEMENT

A. General: Place and secure reinforcement as indicated. Comply with CRSI publications "Manual of Standard Practice" and "Placing Reinforcing Bars".
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
   2. Do not bend bars more than once.
   3. Do not bend or straighten reinforcement in a manner injurious to the material, such as heating.
   4. Do not use bars with kinks or bends not indicated.
   5. Do not use bars with reduced cross-section due to corrosion or other cause.
   6. Remove and replace all defective bars.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Space reinforcement as indicated. If not indicated, maintain clear spacing of not less than the bar diameter, 1-inch, or 1-1/3 times the maximum aggregate size, whichever is greater. Where parallel reinforcing is placed in more than one horizontal layer, place as many bars as possible in the outboard layer, maintaining the required lateral clearances and spacing’s. Place bars in the inboard layer in direct vertical alignment with the bars of the outboard layer. Maintain not less than 1-inch or the maximum bar diameter in the inboard/outboard layers, whichever is greater, clear space between vertically stacked bars.

D. Accurately position, support, and secure reinforcement against displacement.
1. Maintain reinforcing steel positions during placement operations. Properly reset any reinforcement that is displaced by runways, workmen and other causes.

E. Locate and support reinforcement with bar supports to maintain minimum concrete cover as indicated or as required by ACI 318.

F. Do not tack weld crossing reinforcing bars.
   1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

G. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

H. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.10 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction or Cold Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
   2. Locate horizontal joints in walls and columns as indicated.
   3. Space vertical joints in walls as indicated and as may be directed by the Architect. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   6. Align joints with reveals indicated. Provide custom cut form boards as required.
   7. Do not place expansion material at cold joints.

C. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, walls and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.11 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, form-release agent, surface retarders, reinforcement, and embedded items is complete and that required inspections have been performed.
   1. Provide protective coatings, coverings and masking’s to protect adjacent Work.
2. Provide temporary runways and other appropriate equipment as necessary to access Work area and to avoid soiling or damage to existing Work.
3. Prevent run-off of concrete hydration water and water polluted by agents and chemicals from soiling existing surfaces or contaminating landscape areas.

B. Do not add water to concrete during delivery, at Project site, or during placement.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
   2. If indicated in mix design accepted by the Architect, water added to concrete shall be observed by the Project Inspector, and shall be recorded on the delivery ticket.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. No visible cold joints or lift lines are acceptable in the completed work.
   3. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
   4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
   5. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   7. Screed slab surfaces with a straightedge and strike off to correct elevations.
   8. Slope surfaces uniformly to drains where required.
   9. Begin initial floating using bull floats or derbies to form a uniform and open-textured surface plane, before excess bleed water appears on the surface.

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

F. Hot-Weather Placement: Comply with ACI 305R and as follows:
1. Maintain concrete temperature below 90 deg. F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.12 FINISHES, GENERAL

A. Architectural Site Concrete Finishes: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
B. Architectural Site Concrete Finishes: Match accepted mockups to satisfaction of Architect.
C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
   1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
D. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

3.13 AS-CAST FORMED FINISHES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects to match the accepted mockups. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding specified limits on formed-surface irregularities.
B. Smooth-Formed Finish is the general finish required for all formed integral-colored concrete, unless otherwise indicated. Rubbed finishes are unacceptable.
C. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
D. Smooth-Rubbed or Sponged Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
E. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part Portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Scrub grout into voids and remove excess grout. When grout
whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

F. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part Portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

G. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

3.14 EXPOSED-AGGREGATE FINISHES

A. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi (6.9 to 10.3 MPa), apply scrubbed finish. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed. Rinse scrubbed surfaces with clean water. Maintain continuity of finish on each surface or area of Work. Remove only enough concrete mortar from surfaces to match design reference sample or mockup.

B. High-Pressure Water-Jet Finish: Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi (31 MPa). Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
   1. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in reveal projection to match design reference sample or mockup.

C. Abrasive Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi and is at least 28 days old. Coordinate with formwork removal to ensure that the surfaces to be abrasive blasted are treated at same age for uniform results.
   1. Surface Continuity: Perform abrasive-blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample or mockup.
   2. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample or mockup.
   3. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference sample or mock up as follows:
   4. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference sample or mockup, as follows:
      a. Brush: Remove cement matrix to dull surface sheen and expose face of fine aggregate; with no significant reveal.
      b. Light: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color; with maximum reveal of 1/16 inch (1.5 mm).
c. Medium: Generally expose coarse aggregate; with slight reveal, a maximum of 1/8 inch (3 mm).

d. Heavy: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter; with reveal range of 1/4 to 5/16 inch (6 to 8 mm).

D. Bush hammer Finish: Perform bush hammer finish on concrete that has achieved a minimum compressive strength of 4500 psi (31 MPa), and has been allow to cure at least 21 days before starting bush hammer surface finish operations.

1. Surface Continuity: Perform bush hammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances of cut as shown on Drawings or to match design reference sample or mockup.

2. Surface Cut: Maintain required depth of cut and general aggregate exposure. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.

3. Remove impressions of formwork and form facings with exception of tie holes.

3.15 SKATEBOARD DETERRENTS

A. General: Install skateboard deterrents in epoxy adhesive supplied by manufacturer, in accordance with manufacturer's instructions.

1. Install as shown. If not shown, install in symmetrical fashion on all formed edges within 4 feet (1.22 m) of adjacent grade, at intervals not to exceed 3 feet (1.1 m) O.C.

3.16 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 305R for hot-weather protection during curing.

B. Begin curing cast-in-place architectural site concrete immediately after removing forms from concrete or after applying as-cast formed finishes to concrete, consistent with mockup preparation. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:

1. Moisture Curing: Keep exposed surfaces of cast-in-place architectural site concrete continuously moist for no fewer 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.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for no fewer than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.

3. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas.
subjected to heavy rainfall within three hours after initial application.
Maintain continuity of coating and repair damage during curing period.

3.17 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports in accordance with the CBC and ACI 301.
   1. Comply with the requirements of Division 01 Section "Quality Control".
   2. Comply with the requirements of Division 01 Section "Quality Control-DSA".

B. Inspections:
   1. Steel reinforcement placement.
   2. Steel reinforcement welding.
   3. Headed bolts and studs.
   4. Verification of use of required design mixture.
   5. Structural concrete placement, including conveying and depositing.
   6. Curing procedures and maintenance of curing temperature.
   7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
      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 mixture. 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/C 1064M; one test hourly when air temperature is 40 deg. F and below and when 90 deg. F and above, and one test for each composite sample.
   5. Compression Test Specimens: ASTM C 31/C 31M.
      a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
      b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
   6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
      a. Test one set of two field-cured specimens at 7 days and reserve one set of two specimens for testing at 56 days.
      b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

12. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.18 DEFECTIVE CONCRETE

A. The following list includes, but is not limited to; concrete that will be deemed to be defective and non-conforming. All such concrete shall be removed and replaced with Work complying with the requirements of the Contract:

1. Concrete not formed as indicated, not true to alignment indicated, not plumb where intended, not level where intended, not true to level or elevation intended.

2. Concrete voided or honeycombed, including voids and honeycombs that have been cut, resurfaced or filled without prior approval of the architect.

3. Concrete with exposed reinforcement.

4. Concrete with inadequate cover over reinforcement.

5. Concrete with embedded foreign objects and debris, including sawdust, wood or metal shavings, nails, cans, trash, etc.

6. Concrete that does not visually match the accepted mockups [or the designated design reference sample].

7. Other non-conforming work.

B. All concrete deemed to be defective by the Architect or in non-conformance with the contract documents is to be removed and replaced from expansion joint or cold joint to expansion joint or cold joint at no cost to the owner. Repair defective concrete as directed by the Architect, at no cost to the Owner.
3.19 SEALERS AND REPELLENTS

A. General: Uniformly apply a continuous sealing coat of sealers or repellents to all exposed surfaces of architectural site concrete by power spray or roller according to manufacturer’s written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete that is less than 28 days old.

B. Penetrating Liquid Floor and Horizontal Surface Treatment (Sealer):
   Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer’s written instructions.
   1. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

C. Penetrating Liquid Wall and Vertical Surface Treatment (Sealer/Repellent):
   Prepare, apply, and finish penetrating liquid repellent treatment according to manufacturer’s written instructions.

3.20 ANTI-GRAFFITI COATING

A. Refer to Section 099620 Permanante Non-Sacrificial Anti-Graffiti Coating.

B. Apply to all exposed architectural site concrete.

C. Apply compatible sealer to exposed architectural site concrete prior to installation of Anti-Graffiti coating.

3.21 REPAIRS, PROTECTION, AND CLEANING

A. Patching or sacking of damaged or defective concrete as a determined by the Architect is not permitted. Remove and replace all damaged or defective concrete from joint to joint. Remove/Repair and cure damaged or defective finished surfaces of cast-in-place architectural site concrete when accepted by Architect. Match repairs to color, texture, and for any replaced work/uniformity of surrounding surfaces and to repairs on approved mockups.

B. Remove and replace cast-in-place architectural site concrete that does not match mockups accepted by Architect.

C. Protect corners, edges, and surfaces of cast-in-place architectural site concrete from damage; use guards and barricades.

D. Protect cast-in-place architectural site concrete from staining, laitance, and contamination during remainder of construction period.

E. Clean cast-in-place architectural site concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

F. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.
   1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural site concrete finishes.

END OF SECTION 32 33 10
SECTION 32 33 13

BICYCLE RACKS

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Bicycle racks.

1.02  RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Mounting surface for bicycle racks.
B. Section 32 13 13 - Concrete Paving: Mounting surface for bicycle racks.

1.03  PRICE AND PAYMENT PROCEDURES
A. See Section 01 23 00 - Alternates, for product alternatives affecting this section.

1.04  REFERENCE STANDARDS

1.05  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. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
C. Shop Drawings: Indicate size, shape, and dimensions, including clearances from adjacent walls, doors, and obstructions.

1.06  DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Handle racks with sufficient care to prevent scratches and other damage to the finish.

PART 2  PRODUCTS

2.01  MANUFACTURERS
A. Outdoor Bicycle Racks:
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02  BICYCLE RACKS
A. Outdoor Bicycle Racks: Device allows user provided lock to simultaneously secure one wheel and part of the frame on each bicycle parked or racked.
   1. Style: Ribbon waves up and down forming interconnected horseshoes.
2. Mounting, Ground: In-ground anchor.
3. Accessories: In-ground grout cover.

B. Indoor Bicycle Racks: Device designed for indoor storage of bicycles; allows user provided lock to simultaneously secure one wheel and part of the frame on each bicycle parked or racked.
   2. Color: As shown on the drawings.

C. Materials:
   1. Pipe: Stainless steel, ASTM A312/A312M, Type 304, Schedule 40S.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine surfaces to receive bicycle racks.
   B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
   C. Do not begin installation until unsatisfactory substrates have been properly repaired.

3.02 PREPARATION
   A. Ensure surfaces to receive bicycle racks are clean, flat, and level.

3.03 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install bicycle racks level, plumb, square, and correctly located as indicated on the drawings.
   C. In-Ground Anchor Installation:
      1. Prepare holes in size according to manufacturer's instructions.
      2. Place anchoring bolts through the holes in the pipe.
      3. Lower rack into holes, ensuring the bottom of lower bends are at least 1-1/2 inch (38 mm) from the ground.
      4. Pour concrete and level rack.
      5. Support until dry.

3.04 CLEANING
   A. Clean installed work to like-new condition. Do not use cleaning materials or methods that could damage finish.

3.05 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 32 33 13
PART 1 GENERAL

1.01 DESCRIPTION

A. Work included:
   1. Order and furnish all labor, materials, supplies, tools, and transportation and perform all operations in connection with and reasonably incidental to complete the installation of the automatic sprinkler irrigation systems as shown on the drawings. Items hereinafter are included as an aid to take off, and are not necessarily a complete list of work items.
   2. Trenching, stockpiling, excavation, materials, and refilling trenches.
   3. Furnishing materials and installation for complete system including piping, valves, fittings, sprinkler heads, automatic controls, and final adjustment of heads to insure complete coverage.
   4. Line voltage connections to the irrigation controllers and low voltage control wiring from controllers to remote control valves.
   5. Replacement of unsatisfactory materials.
   6. Clean-up, inspection and approval.
   7. All work of every description mentioned in the specification and/or addenda thereto, all other labor, and materials reasonably incidental to the satisfactory completion of the work, including clean-up of the site, as directed by the Architect.
   8. Tests.
   9. Record drawings.
   10. Work Specified Elsewhere:
       a. Irrigation water stub-out.
       b. 120 volt A.C. electrical stub-out to controller location.
       c. Irrigation piping in structure.
       d. Irrigation sleeves.
       e. Electrical conduit in structure for 24 volt wire.

1.02 EXPLANATION OF DRAWINGS:

A. Due to the scale of the Drawings, it is not possible to indicate all piping offsets, fittings, sleeves, etc., which may be required. Carefully investigate the conditions affected all of the work and plan accordingly, and furnish all required fittings. Install system in such a manner to avoid conflicts with planting, utilities and architectural features.

B. Do not install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in arc dimensions exist that might not have been considered in engineering. Bring such obstruction or differences to the attention of the Owner's Representative. Notify and coordinate irrigation Work with applicable contractors for location and installation of piping and sleeves through or under walls, pavement and structures. In the event this notification is not given, the Contractor shall assume full responsibility for any revision necessary.
1.03 GENERAL REQUIREMENTS:

A. O.S.H.A. Compliance:
1. All articles and services covered by this specification shall meet or exceed the safety standards established under the Federal Occupational Safety and Health Act of 1970, together with all amendments in effect as of the date of this specification.
2. Codes and Standards:
   a. Comply with all applicable codes and standards.
   b. All work and materials shall be in full accordance with the latest rules and regulations of the National Electric Code; published by the Western Plumbing Officials Association; and other State or local laws regulations. Nothing in these drawings or specifications is to be construed as to permit work not conforming to these codes.
   c. When the specifications call for materials or construction of a better quality or larger size than required by the above mentioned rules and regulations, the provision of the specifications shall take precedence over the requirements of said rules and regulations.
   d. Contractor shall furnish, without extra charge, any additional material and labor when required by the compliance with these rules and regulations, though the work be not mentioned in these particular specifications or shown on the drawings.
   e. The Contractor shall erect and maintain barricades, guards, warning signs, and lights as necessary or required by O.S.H.A. regulations for the protection of the public or workmen.
   f. Any existing buildings, equipment, piping, pipe covering sewers, etc., damaged by the Contractor during the course of his work shall be replaced or repaired by the Contractor in a manner satisfactory to the Owner’s Representative and at Contractor’s own expense, before final payment is made. The Contractor shall be responsible for damage caused by leaks in the piping systems being installed or having been installed under this contract. He/she shall repair, at his/her own expense, all damage so caused, in a manner satisfactory to the Architect.
   g. The Contractor shall pay for all permits, licenses, and fees required.

1.04 SUPERVISION AND WORKMANSHIP

A. The Contractor, personally or through an authorized and competent representative, shall supervise the work constantly, and shall as far as possible keep the same foreman and workmen on the job from commencement to completion. The workmanship of the entire job must in every way be first class, and only experienced and competent workmen will be allowed on the job.

1.05 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

A. The Drawings show, if applicable, existing above and below grade structures and utilities that are known to the Owner. Locate known existing installations before proceeding with construction operations that may cause damage to such installations. Existing installations shall be kept in service where possible and damage to them shall be repaired with no adjustment of Contract Sum. Verify with Owner if As Built drawings are available.
B. If other structures or utilities are encountered, request Owner's Representative to provide direction on how to proceed with the Work. If a structure or utility is damaged, take appropriate action to ensure the safety of persons and property.

1.06 LAYOUT OF WORK

A. The Contractor shall stake out the irrigation system as shown on the drawings. These areas shall be checked by the Contractor and Architect before construction is started. Any changes, deletions or additions shall be determined at this check.

1.07 SEQUENCING AND SCHEDULING

A. Acceptance: Do not install main line trenching prior to acceptance by Owner's Representative of rough grades completed under another Section.

B. Coordination: Coordinate with the work of other sections to insure the following sequence of events:

1. Sleeves and Conduits: Installation of all sleeves and conduits to be located under paving and through walls prior to placement of those materials.

2. Bubbler Heads: Install after placement of tree, but prior to backfill with planter soil mix.

3. On-Structure Equipment: Install piping and risers after waterproofing is accepted.

4. Dripline in Pots: Install flexible riser and seal the penetration of the pot prior to backfill of pot with drainage materials and planter soil mix.

5. Coordinate work schedule with Owner to avoid disruption of landscape maintenance of existing landscaping.

6. Install piping prior to soil preparation (planting soil amendment installation).

1.08 TRENCH INTERFERENCE WITH EXISTING TREE ROOT SYSTEMS:

A. Prior to trenching, layout main and lateral line locations within drip Line of trees and review locations with Owner's Representative. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Owner's Representative.

1.09 INSTRUCTION

A. After the system has been installed and approved, the Contractor shall instruct the Owner's Representative in complete operation and maintenance of the irrigation system.

1.10 SUBMITTALS

A. Submittals:

1. Submit a copy of catalogue information on all material to be used on the project as specified on the legend, notes, details and plans. Redline or highlight exact items on page to be submitted.

2. Substitutions:
   a. No substitution will be permitted without prior written approval by the Architect. If the product is approved and, in the opinion of the Owner's Representative, the substituted product does not perform as well as the specified product, the Contractor shall replace it with the specified product at no additional cost to the Owner.

3. Record Drawings:
a. The Contractor shall maintain in good order in the field office, one complete set of black line prints of all sprinkler drawings which form a part of the contract, showing all water lines, electrical, sprinklers, valves, stub-outs. In the event any work is not installed as indicated on the drawings, such work shall be corrected and dimensioned accurately from the building walls. All underground stub-outs for future connections and valves shall be located and dimensioned accurately from building walls on all record drawings.

4. Controller Chart
a. Provide one laminated controller chart showing the area covered by controller for each automatic controller supplied at the maximum size controller door will allow. Chart shall be a reduced drawing of the actual "as-built" system. If controller sequence is not legible when the drawing is reduced to door size, the drawing shall be enlarged to a size that is readable and placed folded, in a sealed plastic container, inside the controller door.
b. Controller chart shall be a blackline print with a different color used to show area of coverage for each station. Charts must be completed and approved by the Owner’s Representative prior to final inspection of the irrigation system.

5. Maintenance and Operating Instructions and Manuals
a. Contractor shall prepare an Operation and Maintenance Manual, organized in a 3-ring binder, containing the following information.
   1) Contractor’s name, address, and telephone number.
   2) Duration of guarantee, periods as specified herein,
   3) list of equipment with names and addresses of local
   4) manufacturer’s representatives with duration of written
   5) warranties. Complete operating and maintenance
   6) instructions on all equipment spare parts lists and related manufacturer's information.
b. Submit the Operation and Maintenance Manual to the Owner’s Representative within 10 Calendar Days of completion of work of this Section and as a condition of project acceptance.

1.11 P2 MATERIALS
1.12 PIPE AND FITTINGS
A. Main lines (constant pressure); 3” and larger shall be polyvinylchloride (PVC) 1120-200 PSI with ring-tite connections; 2 1/2” and smaller shall be PVC 1120-Schedule 40 plastic pipe.
   1. Join lengths of pipe by means of integrally formed bell end on pipe using rubber ring seal. Use Schedule 40 PVC solvent weld couplings on Schedule 40 pipe.
   2. Ring-tite main line:
      a. At changes in direction or branch mains, use appropriate Ductile Iron rubber ring seal fittings.
      b. Solvent weld main lines:
         1) At changes in direction or branch mains, use appropriate Schedule 40 PVC solvent weld fittings as approved by the Uniform Plumbing Code.
   3. Lateral lines (non-pressure): 3/4” and larger shall be 1120-Schedule 40 PVC plastic pipe. All lateral lines shall be connected with Schedule 40, Type I, Grade I, PVC solvent weld fittings.
   4. Connections between main lines and RCV’s shall be of Schedule 80 PVC (threaded both ends) nipples and fittings.
5. Risers shall be as follows:
   a. Schedule 80 PVC threaded nipples and Schedule 80 PVC ells as shown in the construction details. Offset risers shall be Cobra Connector Model CC-600 (1/2”x6”).

1.13 QUICK COUPLING VALVES
   A. Quick coupling valves shall be as listed on the drawings. Install in 10” diameter plastic valve box as detailed.

1.14 CONTROLLERS
   A. Controllers shall be as listed on the drawings.

1.15 REMOTE CONTROL VALVES
   A. Remote control valves shall be globe/angle pattern with brass, plastic, cast iron, body and bonnet, brass/plastic flow stem and manual bleed petcock. Sizes of remote control valves shall be as listed on the drawings.

1.16 GATE VALVES
   A. 2 ½” and smaller shall be bronze construction with cross handle and screwed connections. 3” and larger shall be cast iron with operating nut (2” square) and “O” ring connections for PVC plastic pipe. Install in 10” diameter plastic valve box as detailed.

1.17 CONTROL WIRE
   A. Control wire shall be copper with U.L. approval for direct burial in ground, size #14-Common ground wire shall have white insulating jacket; control wire shall have insulating jacket of color other than white. Runs over 2,000 lineal feet shall be #12- AWG-UF 600 volt copper wire. Splices shall be made with 3M-DBY seal packs.
   B. Provide a separate ground wire for each controller.
   C. Provide a minimum of two spare control wires into each RCV box for future.

1.18 VALVES BOXES FOR REMOTE CONTROL VALVES
   A. REMOTE CONTROL VALVE BOXES:
      1. Carson Model 1419 or 1324 plastic valve box with plastic lid or approved equal. Lid shall be marked: "Irrigation Control Valve." Size of box as required.
      2. Heat brand controller letter and numbers into lid. Minimum text height to be 2”
      3. GATE VALVE AND QUICK COUPLING VALVE BOXES:
         a. Carson Model 910 plastic valve box with plastic lid or approved equal.
         b. Heat brand the letters “GV” into lid. Minimum text height to be 2”
   4. DRIP COMPONENT BOXES:
      a. 6” round black plastic valve box with plastic lid.
      b. Heat brand the letters into lid as detailed. Minimum text height to be 1”

1.19 SPRINKLER HEADS
   A. All sprinkler heads shall be as listed on the drawings.

1.20 BACKFLOW PREVENTION DEVICE
   A. Backflow prevention device shall be the reduced pressure type with gate valves, check valves, test cocks, reduced pressure chamber and air vent.
Install 12” above finish grade. Provide a freeze preventative blanket around backflow assembly. Blanket shall be green.

B. All metallic pipe and fittings installed below grade shall be may be wrapped with an approved asphaltic tape.

1.21 BACKFLOW PREVENTION DEVICE ENCLOSURE
A. Enclosure shall be as listed on the drawings.

1.22 DRIPLINE & DRIPLINE COMPONENTS
A. Dripline shall be as listed on the drawings.

1.23 FLOW SENSOR
A. Flow sensors shall be as listed on the drawings.

1.24 STRAINER
A. Dripline strainer shall have a plastic housing, MIPT x MIPT connections with removable screen. Rain Bird model PRB-100 with 100 mesh stainless steel screen.

1.25 PRESSURE REDUCING VALVE
A. Pressure reducing valve shall be diaphragm type, bronze, construction with integral stainless steel strainer and union. Pressure range 25-75 PSI adjustable. Watts model 600 size as required.

1.26 MISCELLANEOUS INSTALLATION MATERIALS
A. Solvent cement and primer for solvent weld joints shall be of make and type approved by manufacturer(s) of pipe and fittings. Cement shall be maintained at proper consistency throughout use.
B. Lubricant for assembling rubber ring seal joints shall be of make and type approved by manufacturer of pipe.
C. Pipe joint compound shall be non-hardening, non-toxic materials designed specifically for use on threaded connections in water carrying pipe. Performance shall be same as RectorSeal #5.

1.27 MISCELLANEOUS EQUIPMENT
A. Provide all equipment called for by the drawings.
B. Provide to the Owner, at completion of the maintenance period, three (3) each of all operating and servicing keys and wrenches required for complete maintenance and operation of all heads and valve. Include all wrenches necessary for complete disassembly of all heads and valves.

1.28 P3 INSTALLATION

1.29 PREPARATION
A. Schedule and coordinate placement of materials and equipment in a manner to effect the earliest completion of work in conformance with construction and progress schedule.

1.30 HANDLING AND STORAGE
A. Protect work and materials from damage during construction and storage as directed by the Owner's Representative.
B. Handle plastic pipe carefully; especially protect it from prolonged exposure to sunlight.
1.31 LAYOUT

A. Lay out work as accurately as possible in accordance with diagrammatic drawings.

B. Where site conditions do not permit location of piping, valves and heads where shown, notify Architect immediately and determine relocation in joint conference.

C. Run pipelines and automatic control wiring in common trenches wherever practical.

1.32 EXCAVATING AND TRENCHING

A. Excavation shall be in all cases ample in size to permit the pipes to be laid at the elevations intended and to permit ample space for joining.

B. Make trenches for pipelines deep enough to provide minimum cover from finish grade as follows:
   1. 3” and larger mainline 24” minimum cover over main lines to control valves and quick coupling valves.
   2. 2.5” and smaller mainline 18” minimum cover over main lines to control valves and quick coupling valves.
   3. 18” minimum cover over control wires from controller to valves.
   4. 12” minimum cover over RCV controlled lateral lines to sprinkler heads.
   5. Restore surfaces, existing underground installations, etc., damaged or cut as a result of excavations, to original conditions in a manner approved by the Architect.
   6. Where other utilities interfere with irrigation trenching and pipe work, adjust the trench depth as instructed by the Architect.

1.33 ASSEMBLING PIPELINES

A. All pipe shall be assembled free from dirt and pipe scale. Field cut ends shall be reamed only to full pipe diameter with rough edges and burrs removed.

B. Rubber Ring Seal Joint:
   1. Use factory made male end or prepare field-cut male end to exact specifications of factory made end.
   2. Carefully clean bell or coupling and insert rubber ring without lubricant. Position ring carefully according to manufacturer’s instructions.
   3. Lubricate male end according to manufacturer’s instruction and insert male end to specified depth. Use hands only when inserting PVC pipe.
   4. Thrust blocks shall be provided where necessary to resist system pressure on ring-tite pipe and fittings. Blocks shall be concrete and the size shall be based on an average soil safe bearing load of 700# per square foot.
   5. Form thrust blocks in such a manner that concrete comes in contact only with the fittings. Thrust blocks shall be between solid soil and the fittings.
   6. Solvent weld joint:
      a. Prepare joint by first making sure the pipe end is square. Then, de-burring the pipe end, and clean pipe and fitting of dirt, dust and moisture.
      b. Dry insert pipe into fitting to check for proper sizing. Pipe should enter fitting 1/3 to 2/3 depth of socket.
      c. Coat the inside socket surface of the fitting and the male end of the pipe with P-70 primer (manufactured by Weld-On). Then without
delay, apply Weld-On 711 cement liberally to the male end of the pipe and also apply 711 cement lightly to the inside of the socket. At this time, apply a second coat of cement to the pipe end.

d. Insert pipe immediately into fitting and turn 1/4 turn to distribute cement and remove air bubbles. The pipe must seat to the bottom of the socket and fitting. Check alignment of the fitting. Pipe and fitting shall be aligned properly without strain to either.

e. Hold joint still for approximately thirty (30) seconds and then wipe the excess cement from the pipe and fitting.

f. Cure joint a minimum of thirty (30) minutes before handling, at least six (6) hours before allowing water in the pipe.

7. Threaded joint:
   a. Field threading of plastic pipe or fittings is not permitted. Only factory formed threads will be permitted.
   b. Factory made nipples shall be used wherever possible. Field cut threads in metallic pipe will be permitted only where absolutely necessary. When field threading, cut threads accurately on axis with sharp dies.
   c. All threaded joints shall be made up with pipe joint compound. Apply compound to male threads only.
   d. Where assembling metallic pipe to metallic fitting or valve, not more than three (3) full threads shall show when joint is made up.
   e. Where assembling to threaded plastic fitting, take up joint no more than one full turn beyond hand tight.
   f. Where assembling plastic pipe, use strap type friction wrench only; do not use metal-jawed wrench.

8. Cap or plug openings as pipeline is assembled to prevent entrance of dirt or obstructions. Remove caps or plugs only when necessary to continue assembly.

9. Where pipes or control wires pass through sleeves, provide removable non-decaying plug at ends of sleeve to prevent entrance of earth.

1.34 REMOTE CONTROL VALVES

A. Install where shown on drawings and group together where practical. Limit one remote control valve per box. No exceptions!

B. Locate valve boxes 12” from and perpendicular to walk edges, buildings and walls. Provide 12” between valve boxes where valves are grouped together.

C. Thoroughly flush main line before installing valves.

D. Install in shrub or groundcover areas where possible.

E. Label control line wire at each valve with a 2 1/4” x 2 3/4” polyurethane I.D. tag, indicating identification number of valve (controller and station number). Attach label to control wire.

1.35 AUTOMATIC CONTROL WIRE

A. Run lines along mains wherever practical. Tie wires in bundles with pipe wrapping tape at 10’ intervals and allow slack for contraction between strappings.

B. Loop a minimum of three (3) feet of extra wire in each valve box; both control wire and ground wire.

C. Connections shall be made by crimping bare wires with brass connectors and sealing with watertight resin sealer packs.
D. Splicing will be permitted only on runs exceeding 2500’. Locate all splices at valve locations within valve boxes.

E. Where control lines pass under paving, they shall pass through Schedule 40 electrical PVC conduit. Do not tape wire in bundles inside conduit.

1.36 AUTOMATIC CONTROLLER

A. Provide and install automatic irrigation controller in approximate locations shown on drawings. The exact location will be determined on the site by the Architect. Provide conduit and wire and connect to 120 volt switch accessible to controller for ease of maintenance.

B. Connect control lines to controller in sequential arrangement according to assigned identification number on valve. Each control line wire shall be labeled at controller with a permanent non-fading label indicating station number of valve controlled. Attach label to control wire.

C. Provide each irrigation controller with its own independent low voltage common ground wire.

D. Provide each pedestal controller with its own ground rod. Separate the ground rods by a minimum of eight feet. The ground rod shall be an eight foot long by 5/8” diameter U.L. approved copper clad rod or as recommended by controller manufacturer. Install no more than 6” of the ground rod above finish grade. Connect #8 gauge wire with a U.L. approved ground rod clamp to rod and back to ground screw at base of controller with appropriate connector. Make this wire as short as possible, avoiding any kinks or bending. Install a minimum of 8’ away from pedestal housing base unless otherwise noted.

1.37 MOISTURE SENSOR

A. Provide and install moisture sensors in approximate locations shown on drawings. The exact location will be determined on the site by the Architect. Install as detailed.

1.38 BUBBLERS, SPRINKLER HEADS AND QUICK COUPLING VALVES

A. Thoroughly flush lines before installing heads, bubblers or QCV’s.

B. Locate bubblers, heads and QCV’s as shown in the drawings and details.

C. Adjust sprinkler heads for proper distribution and trim.

D. Install lawn heads 1” above grade in seeded lawn area at time of installation. Lower to finished grade after turf is well established and as directed by Architect.

1.39 DRIPLINE AND DRIPLINE COMPONENTS

A. Thoroughly all flush lines driplines.

B. Install dripline a minimum of 12” away from all buildings and 6” off hardscapes for shrubs and groundcover. 2” of paving for all no-mow or sod type grasses.

C. Space driplines equally throughout the planting area as detailed. Refer to legend for emitter and row spacing of dripline. Adjust alternate rows so emitters are spaced in a triangular pattern.

D. For slopes greater than 10:1, modify dripline row spacing on the bottom 1/3 of the slope to be 25% greater at the bottom of the slope.
E. Install flush valves at the low end of each drip zone minimum of 2 valves are required for each valve. Refer to details for installation instructions.

F. Install air vacuum relief valve(s) at high point(s) of each planting area. Refer to drawings for approximate locations. Revise locations in field based on actual grades of the site. Locate 1 valve per every 500’ of dripline. Refer to details for installation instructions.

G. Thoroughly saturate soil prior to planting. Provide additional surface watering as required to keep plant root systems moist during planting establishment period.

1.40 BACKFILLING

A. Backfill only after piping and wire has been inspected and approved.

B. Backfill material shall be the earth excavated from the trenches, free from rocks, concrete chunks, and other foreign or coarse materials. Carefully select backfill that is to be placed next to plastic pipe to avoid any sharp objects which may damage the pipe.

C. All pipe under asphalt paving shall be backfilled with 4” of clean sand on all sides of pipe.

D. Place backfill materials in 6" layers and compact by jetting or tamping to a minimum compaction of 90 percent of original soil density.

E. Dress off areas to finish grade and remove excess soil, rocks, or debris remaining after backfill is completed.

F. If settlement occurs along trenches, and adjustments in pipes, valves, and sprinkler heads, soil, sod, or paving are necessary to bring the system, soil, sod, or paving to the proper level or the permanent grade, the Contractor, as part of the work under this contract, shall make all adjustments without extra cost to the Owner.

1.41 FIELD QUALITY CONTROL

A. Coverage Tests:
   1. Perform coverage tests in the presence of Owner Representative after sprinkler or drip system is completed. Test system to assure that all areas are irrigated completely and uniformly.
   2. Do not spray onto pavement or structures. Adjust arc nozzles as needed to provide full coverage without over spray.
   3. Adjusting and Cleaning:
      a. System adjustment:
         1) Valves: Adjust flow for proper operation.
         2) Heads: Adjust for alignment and coverage.
         3) If it is determined that coverage could be improved by adding additional driplines or a nozzle change, make such changes as required to provide adequate coverage to all plant material.
         4) Perform final cleaning of all risers, dripline, heads, and equipment for proper operation. Demonstrate operation and uniform coverage in the presence of the Owner’s Representative prior before final acceptance.

1.42 TESTING

A. Perform test as specified below. Remake any faulty joints with all new materials. Use of cement or caulking to seal leaks is absolutely prohibited.
B. Contractor shall:
C. Notify the Architect at least three (3) days in advance of testing.
D. Perform testing at his/hers own expense.
E. Center load piping with small amount of backfill to prevent arching or slipping under pressure. No fitting shall be covered
F. Apply the following tests after welded plastic pipe joints have cured at least twenty-four (24) hours.
   1. Ring-Tite Mainline:
      a. Remove all the air from the piping system then test live (constant pressure) and QCV lines hydrostatically at 125 PSI minimum. Lines will be approved if test pressure is maintained for two (2) hours. Maintain pressure during this time period and measure the amount of water required to maintain that test pressure. Approved tables of allowable loss are below, and the line will be approved or not approved as such results may indicate. The Contractor shall make tests and repairs as necessary until test conditions are met.
      b. Allowable leakage for PVC plastic pipe with elastomeric joints in U.S. gallons per hour at a test pressure of 150 PSI.
         c. 4”  -  0.30 gallons per 1000 ft. or 50 joints
         d. 6”  -  0.45 gallons per 1000 ft. or 50 joints
      e. Solvent Weld Mainline:
         1) Remove all the air from the piping system then test live (constant pressure) and QCV lines hydrostatically at 125 PSI minimum. Lines will be approved if test pressure is maintained for six (6) hours. The lines shall be restored to the original test pressure. The Contractor shall make tests and repairs as necessary until test conditions are met.
         f. Test RCV controlled lateral lines with water at line pressure and visually inspect for leaks. Retest after correcting defects.

1.43 GUARANTEE

A. It shall be the responsibility of the Contractor to fill and repair all depressions and replace all necessary lawn and planting due to the settlement of irrigation trenches for one year following completion and acceptance of the job.
B. The Contractor shall also guarantee all materials, equipment and workmanship furnished by him to be free of all defects of workmanship and materials, and shall agree to replace at his expense, at any time within one year after installation is accepted, any and all defective parts that may be found.

1.44 CLEAN-UP

A. When work of this section has been completed and at such other times as may be directed, remove all trash, debris, surplus materials, and equipment from site.

1.45 WINTERIZATION OF IRRIGATION SYSTEM

A. The Contractor shall be responsible for draining irrigation system in preparation for the first winter after construction has been completed. Instruct Owner’s representatives in proper procedures.
B. Winterization shall proceed as follows:
1. Close gate valve in irrigation main line located at the water meter.
2. Insert quick coupling quill, connected to air compressor, into quick coupling valve located at water meter.
3. Following start of air compressor, program irrigation controller through three (3) complete cycles or until all water has been forced out of the system.
4. Insert quick coupling quill into QCV at dead end runs of main line to force out all remaining trapped water.
5. Remove compressor, leaving gate valve to irrigation system closed.

END OF SECTION 32 84 23
PART 1 - GENERAL

1.01 SECTION INCLUDES:
A. Weeding.
B. Finish grading for lawns
C. Finish grading for planting areas.

1.02 RELATED REQUIREMENTS
A. Division 31 Section Site Clearing
B. Division 31 Section Earthwork
C. Division 32 Section: Landscape Work

1.03 DEFINITIONS
A. Finish Grading: finish grading shall consist of adjusting and finishing soil surfaces with site or imported topsoil, raking grades to a smooth, even, uniform plane. Remove and legally dispose of all extraneous matter off site. Facilitate natural run-off water and establish grades and drainage indicated as part of the contract work.

B. 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 3/4-inches (19 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

C. Finish Grading: Finish grading shall consist of finishing surfaces by raking smoothly and evenly to facilitate natural run-off water, and by removing and disposing of extraneous matter.

D. Sub-grade: The surfaces upon which additional specified materials are to be placed, prepared, or constructed.

E. Rough Grade: The establishment of grades to required tolerances.

F. Finish Grade: Spot elevations (grades) are indicated based on the best available data. Contract Civil Drawings are referenced to provide additional site grading information. It is intended that constant slopes are maintained between spot elevations.

G. 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.

1.04 MATERIAL OWNERSHIP
A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.
1.05 EXISTING UTILITIES

A. Stake and mark the location of existing utilities before commencing work.
B. Retain and protect in operating condition all active utilities traversing the site designated to remain.

1.06 QUALITY ASSURANCE

A. Finish grade shall conform to contours, grades, lines, and shapes, as indicated on Contract Drawings, with uniform slopes between finish grades or between finish grades and existing grades.
B. Establish finish landscape grades in a continuous, uniform line, resulting in a uniform surface with no ridges or water pockets.
C. Finish landscape grade tolerance shall be 0.04-feet plus-or-minus from finish elevations indicated on site drawings.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS:

A. Topsoil: A natural, fertile, friable soil, free from stones, roots, clods larger than 1" in diameter, noxious seeds, weeds, subsoil, undesirable insects, plant disease or any other natural objects detrimental to normal plant growth.
1. Silt plus clay content of the import soil shall not exceed 20% by weight with a minimum 95% passing 2.0-millimeter sieve.
2. Total pore space content on a volume/volume basis shall be at least 15 percent at field capacity.
3. Permeability rate shall be not less than one inch per hour or more than 20 inches per hour.
4. The sodium absorption ratio (SAR) shall not exceed 6 and the electrical conductivity (ECE) shall not exceed 2.0 milliohms per centimeter at 25 degrees centigrade.
5. Soluble boron shall be no greater than 1.0 part per million (mg/l).
7. Maximum concentration of soluble chloride shall be 150 parts per million.
8. Maximum concentration of heavy metals shall not exceed the following when the pH is between 6 and 7:
   a. Arsenic: 1 ppm
   b. Cadmium: 1 ppm
   c. Chromium: 5 ppm
   d. Cobalt: 1 ppm
   e. Lead: 15 ppm
   f. Mercury: 0.5 ppm
   g. Nickel: 2.5 ppm
   h. Selenium: 1.5 ppm
   i. Silver: 0.25 ppm
   j. Vanadium: 1.5 ppm
9. Petroleum hydrocarbons shall not exceed 100 mg/kg dry soil.
10. Aromatic volatile organic hydrocarbons shall not exceed 2 mg/kg dry soil.

B. Obtain imported topsoil from approved local sources.
C. All topsoil to be used for planting, regardless of whether import or on-site in origin, shall be tested as described in Part 3 of Section 02900.
PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verification of conditions: Prior to commencing the finish grading, review the installed work of other trades and verify that their work is complete.
   1. Rough Grading: Grading in planting areas (except raised planter areas) shall be established to within plus or minus 0.10 foot prior to beginning of finish grading.

B. Import topsoil only when necessary to supplement site soil to achieve grades shown on Drawings, or if site soil is unsuitable for planting.

3.02 PREPARATION:

A. Weeding: Before finish grading, weeds and grasses shall be dug out by the root or sprayed with an herbicide and disposed of off-site. This procedure is outlined in Section 02900-Landscape Work.

B. Remove debris, roots, branches, weeds, stones, in excess of 1/2-inch (13 mm) in size and clumps of earth that do not break up. Before and during finish grading, remove weeds and grasses, including roots, and dispose off-site.

C. Remove soil contaminated with petroleum products and legally dispose off-site.

3.03 INSTALLATION:

A. General: When rough grading and weeding have been completed, and the soil has dried sufficiently to be readily worked, lawn and planting areas shall be graded to the elevations indicated on the Drawings.
   1. Grades indicated on Drawing are grades that will result after thorough settlement and compaction of the soil.
   2. Grades not otherwise indicated shall be uniform finish grades and, if required, shall be made at the direction of the Architect.
   3. Finish grades shall be smooth, even, and a uniform plane with no abrupt change of surfaces.
   4. Soil areas adjacent to buildings shall slope away from the building to allow a natural run-off of water, and surface drainage shall be directed as indicated on the drawings by remodeling surfaces to facilitate the runoff water at 2% minimum grade.
   5. Low spots and pockets shall be graded to drain properly.

B. Drainage: Finish grade with proper slope to drains.
   1. Flow lines, designated or not, shall be graded and maintained to allow free flow of surface water.
   2. If any drainage problems arise during construction period due to Contractor's work (such as, but not limited to, low spots, slides, gullies and general erosion), the Contractor shall be responsible for repairing these areas to a condition equal to their original condition, and in so doing shall prevent further drainage problems from occurring.

C. Prior to placing backfill, remove rock, aggregate base, concrete, and deleterious materials to a depth of 18 inches below soil grade in planter areas. Cross-rip subsoil of friable soil to a depth of 12-inches.
   1. Place a minimum of [15-inches] <Insert other values> of topsoil backfill in planters.
   2. Refer to Section 02900 "Landscaping" for soil materials.
D. Toe of slope: To prevent soil creep or erosion across pavement, where pavement (walk, curb, etc.) is at the toe of a slope, finish grade is to level out or swale slightly at least 12-inches before reaching pavement.

E. Moisture Content: The soil shall not be worked when the moisture content is so great that excessive compaction occurs, nor when it is so dry that dust may form in the air or that clods do not break readily. Water may be applied, if necessary, to provide moisture content for tilling and planting operations. It is the Contractor’s responsibility to control dust that is spread as a result of grading operations.

F. Grades: The finish grade in areas to be planted with turf shall be 1-inch below grade of adjacent pavement, walks, curbs, or headers. Finish grade in shrub areas shall be 1 1/2-inches below adjacent surfaces. Exceptions may be made when drainage conditions require flush grades, as directed by the Architect.

G. Compaction: Soils in planted areas shall be loose and friable, yet firm enough that no settling occurs from normal foot traffic or irrigation.

3.04 FIELD OBSERVATION:

A. It is the Contractor’s responsibility to contact the Architect 48 hours or two working days in advance of each agreed observation or conference.

B. Schedule for On-Site Reviews: at completion of finish grading and prior to any planting operations.
   1. See “Site Observation” in Part 3 of Section 02900-Landscape Work to coordinate inspections and review of work.

END OF SECTION 32 91 19
PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Soil Prep and Fertilization.
B. Planting Operation.
C. Planting Materials.
D. Topsoil and Planter Mix.
E. Agronomic Testing.
F. Drainage Materials.
G. Jute Mesh and Erosion Control.
H. Mulching.
I. Hydroteedding
J. Sod
K. Pruning
L. Tree stabilization.
M. Edgings.
N. Tree grates.
O. Root Barriers.

1.02 RELATED REQUIREMENTS

A. Division 12 Section Site Furnishings.
B. Division 31 Section Site Clearing
C. Division 32 Section Finish Grading
D. Division 32 Section Landscape Irrigation
E. Division 32 Section Landscape Maintenance
F. Division 33 Section Storm Drainage Utilities

1.03 REFERENCE STANDARDS

A. American Association of Nurserymen, Inc. (AAN)

1.04 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
B. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.

D. Root Zone: Imported specialty soil manufactured offsite by TMT Enterprises to be placed beneath turf fields.

E. Root Zone: Imported specialty soil manufactured offsite by TMT Enterprises to be placed beneath turf fields.

F. Clump: Where three or more young trees were planted in a group and have grown together as a single tree having three or more main stems or trunks.

G. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.

H. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.

I. Finish Grade: Elevation of finished surface of planting soil.

J. Sub-grade Elevations: Excavation, filling and grading required to establish elevations is shown on drawings. Coordinate all work with grading contractor in order to arrive at rough grades that will allow tolerance for topsoil in planting areas, soil amendments and ornamental mulch as required in other sections of this specification. Contractor to assume tolerance of rough grades established at ± 0.09 feet (less than 1 tenths of a foot).

K. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

L. Multi-Stem: Where three or more main stems arise from the ground from a single root crown or at a point right above the root crown.

M. Planting Soil: Native or imported topsoil; mixed with soil amendments.

N. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

O. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

P. Pruning: As designated on contract drawings. Items not specifically indicated or specified, but normally required to conform with such work, are considered part of the work.

1.05 SUBMITTALS

A. WITHIN 30 DAYS OF START OF THE ROUGH GRADING OPERATIONS:
1. Submit a certificate indicating all plant material has been secured for the project and is available.
2. Submit documentation that all plant material has been ordered in accordance with Article 1.6 of this section.
B. CERTIFICATION: Submit the following:
1. Certificates of inspection as required by governmental authorities when transporting materials into the state.
2. Bulk Materials: Submit a certificate of delivery for all material in containers or bulk.

C. TEST REPORTS: Submit the following:
1. Agronomic Soils Laboratory Test Report(s) including required amendments and maintenance recommendations.

D. PRODUCT DATA: Submit the following:
1. In accordance with Division 1 Section "Submittal Procedures", submit complete manufacturer descriptive literature and specifications for proprietary materials and any additional items required by the Architect. Prior to start of construction and submittals; furnish to the Architect the list of items to be submitted and reviewed.
   a. Soil Amendments (as identified in Agronomic Soils Report).
   b. Fertilizer (as identified in Agronomic Soils Report).
   c. Plant Tablets.
   d. Stakes and Guys.
   e. Tree Ties and Vine Ties.
   f. Hydroseed Materials.
   g. Mulch.
   h. Hydroseding: Furnish certificate, in writing, stating that the hydroseding has been installed as specified.
   i. Edging Material.
   j. Filter Fabric.
   k. Drainage Materials.
   l. Accessory Material.
   m. Other soil additives per Agronomic Soils Report.
   n. Submit other data substantiating that materials comply with specified requirements. Such certificates may be tags, labels, and/or manufacturers literature. All submittals shall be reviewed and accepted by the Architect before contractor begins work.
   o. Substitution Request
      1) If any plant specified is not obtainable, submit a written substitution request to the Architect during the bidding period.
      2) Substitutions of plant material will not be permitted unless accepted in advance in accordance with the provisions of Division 1 Section "Product Requirements."
      3) The Contractor is responsible for contract growing all required plant material for to project to ensure availability in the size and requirements of the project.
      4) All substitution requests for any material must be made during the bid process. No substitution requests will be permitted after the bid process or during.

p. With submittal of Bid Documents, submit complete list of plant materials to be provided, including unit prices for plants and for installation. Include:
   1) Quantity.
   2) Size.
   3) Botanical Name.
   4) Plant Unit Price.
   5) Installation Unit Price.
2. PLANTING SCHEDULE: Submit proposed planting schedule at least two months prior to planting any materials, indicating dates for each type of landscape work coinciding with normal seasons for such work. Correlate with specified maintenance periods to provide maintenance from date of substantial completion. If dates need to be revised after acceptance of planting schedule, document reasons for delays and submit for acceptance.

3. Submit two photos of each tree shrub and groundcover with a person in the image to be used on the project to the architect for review. Photos are to be of the actual material tagged, secured and to be used for the project at the sourced nursery. No plants may be delivered or planted prior to approval by Architect.

1.06 QUALITY ASSURANCE

A. QUALIFICATIONS

1. Nursery Qualifications: Regularly engaged, for the preceding ten years, in the production of planting materials equivalent in species and size to those required.
   a. Stocked, and having a demonstrated ability to provide plant materials required within the constraints of the accepted construction schedule.
   b. Landscaper’s Qualifications: Regularly engaged and specializing, for the preceding ten years, in the installation and maintenance of planting materials equivalent in species and size to those required.
      1) Capable of furnishing a verifiable list of not less than five projects of equivalent type successfully completed within the preceding two years.
      2) Subcontracts: Landscape work to a single firm specializing in landscape installation.


3. Source Quality Control
   a. General: Comply with regulations applicable to shipping of landscape materials.
   b. Analysis and Standards: All materials shall be of standard, approved and first-grade quality and shall be in prime condition when installed and accepted. Any commercially processed or packaged material shall be delivered to the site in the original unopened container bearing the manufacturer’s guaranteed analysis. The Contractor shall supply the Architect with a sample of all materials accompanied by analytical data from an approved laboratory source illustrating compliance of bearing the manufactures guaranteed analysis.

4. Soil-Testing Laboratory Qualifications: An independent 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.

5. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
a. Report suitability of topsoil for plant growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

6. 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 3/4-inches (19 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
   a. Obtain topsoil only from naturally, well drained sites where topsoil occurs in a depth of not less than 4"; do not obtain from bogs or marshes. All topsoil is to be tested and analyzed by an independent laboratory before delivery to site, as indicated in Article 3.3.

7. Contractor shall provide the Architect with location of soil, crops previously planted on such soil within the last two years, and the USGS soil survey classification and name.

8. Trees, Shrubs and Plants: Provide trees, shrubs and plants of quantity, size, genus, species and variety shown and scheduled for landscape work and complying with recommendations and requirements of ANSI Z60.1-1980 "American Standard for Nursery Stock". Provide healthy, vigorous stock, grown in recognized nursery in accordance with good horticultural practice and free from disease, insects, insect eggs, larvae and defects such as knots, sun-scald, injuries, abrasions, overlapping surface roots, or disfigurement. Central leaders of all trees shall be intact, undamaged, with evenly spaced lateral branches.
   a. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches (150 mm) above the ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

9. Label all trees and shrubs with securely attached waterproof tag bearing legible designation of botanical and common name. Where formal arrangements and consecutive order of trees is shown, select stock for uniform height/spread, and label with number to assure symmetry in planting.

10. Stock Review: The Architect will review trees and shrubs at site before planting with requirements for genus, species, variety, size and quality. The Architect retains right to further review trees and shrubs for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of the work. Remove rejected vegetation immediately from project site. Contractor shall request review of such stock by the Architect by delivering notice, in writing, 72 hours in advance.

11. Tree Sourcing: All trees are to be secured and purchased through Paul Brunning & Associates, 714-846-2718. Contractor will be responsible for contacting, securing and obtaining materials as identified on the plans. Deposits may be required to secure and maintain plant material.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver exterior plants freshly dug.
B. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

C. Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.
1. Protect plants from sun or drying winds. Protect and maintain plants that cannot be planted immediately upon delivery.
2. Do not drop plant material.
3. Do not pick up container planter material by stems or trunks.
4. Protect from wind.
5. Water as required.
6. Do not prune trees and shrubs before delivery except as approved by Architect. Do not bend or bind trees or shrubs in such manner as to damage bark, break branches or destroy natural shape. Provide protective covering during delivery, and provide protection on site from traffic, pedestrians, and deleterious effects of climate while planting operations are in progress. Dropped or damaged stock will not be accepted.
7. Deliver trees and shrubs after preparations for planting have been completed and plant immediately after approval of plant materials locations. If planting is delayed more than 6 hours after delivery, set trees and shrubs in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture. Do not remove container grown stock from containers until planting time.
   a. Do not pick up plants by stems or truck. Handle planting stock by root ball.
   b. Do not remove container - Grown stock from containers before time of planting.
   c. Water root systems of exterior plants stored onsite with a fine-mist spray.
   d. Water as often as necessary to maintain root systems in a moist condition.
8. Plant material shall not be stored on the jobsite for more than 48 hours before planting. Contractor shall schedule nursery deliveries in sub-groups as necessary to comply with this requirement.
9. Deliver accessory materials in manufacturer's original, unopened packaging with identifying labels affixed and legible in accordance with state law. Deliver plants with identifying tags affixed. Contractor shall notify Architect 48 hours in advance of plant material delivery for observation. Review plants with Landscape Architect to confirm that they are the plants which had previously been tagged and supplied. The Architect reserves the right to reject the following:
   a. Plant materials not identifiable as previously selected.
   b. Materials not accompanied by required certificates.
   c. Plant materials where damage to rootball, trunks, or desiccation of leaves has been caused by inadequate protection during delivery.
   d. Plant material not matching the form, shape, or growth habit required for the design intent of the Project.
   e. Horticultural or visual defects in material.
   f. Plant material pruned prior to delivery.
   g. Plant material with detrimental pests.
1.08 PROJECT CONDITIONS

A. Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.
   1. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of substantial completion.
      a. Plant or install materials during normal planting seasons for each type of landscape work required.
   2. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed without having detrimental effects on the plant material, or finished product.
   3. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Architect.
      a. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.
   4. Contractor shall verify locations of all existing utilities, whether shown on plans or not. The Contractor shall notify members of Underground Service Alert (U.S.A.) two (2) working days in advance of performing any excavation work by calling the toll-free number 1-800-227-2600
   5. After determining location of underground utilities, perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.
   6. When conditions detrimental to plant growth are encountered, such as rubble fill, hardpan condition, adverse drainage conditions, or obstructions, notify the Architect before planting. Remove all material deemed unsuitable for plant growth as directed by the Architect.
   7. No landscape materials may be planted before an irrigation operation and coverage test is completed by the Architect.
   8. No landscape materials may be planted before finish grade is reviewed by the Architect.
   9. Existing Trees:
      a. Prior to the beginning of any clearing, grubbing, trenching, or excavation on site, the general contractor, grading contractor, project arborist, landscape contractor, and the Architect shall meet in a pre-construction conference to discuss grading near existing trees.
      b. The contractor shall protect all existing trees and shrubs scheduled to remain against injury or damage, including cutting, breaking or skinning of roots, trunks or branches. No blasting of rock shall occur in any area adjacent to existing trees without prior written consent of the Architect.
      c. No trees or shrubs are to be removed, trimmed, or cut without prior approval of the Architect.
      d. Prior to the beginning of the clearing and grading phase of the project, a continuous, temporary, six foot (6') high chain link fence shall be erected around the drip line of all trees scheduled to remain, unless otherwise specified by the Architect. The temporary fencing shall be erected prior to commencing any other work on the project. No construction activity shall be allowed within the limits of this fencing unless directed by the Architect. The temporary fencing shall remain in place during the entire
construction period and shall not be removed until directed by the Architect.

e. Grading beneath trees to be saved shall be given special attention. Every effort shall be made to avoid creating conditions adverse to the tree’s health. The natural ground within the drip lines of trees to be preserved shall remain as undisturbed as possible. Grading within the protected root zone of trees to be preserved will not be permitted unless specifically approved by the Architect prior to beginning of proposed grading.

f. If during construction or grading (grading, excavation, etc.) tree roots of 2" in diameter or greater are encountered, work shall stop immediately and a Certified Arborist, approved in advance by the Architect, shall be contracted for a root inspection. Root cutting of any roots over 2" in diameter must have prior approval from the Architect. All cuts are to be made with appropriate equipment, as to not affect the plant material.

g. Major roots one inch (1") or greater in diameter encountered within the drip line of the tree in the course of excavation or trenching shall not be cut and shall be kept moist and covered with earth as soon as possible. Shredding of roots or damaged caused by trenching or grading equipment is not permitted.

h. Roots one half inch (1/2") to one inch (1") in diameter which are severed shall be trimmed cleanly and covered with earth as soon as possible.

i. All trenching beneath the drip line of trees to remain shall be done with hand tools only. No mechanical trenching or excavation is allowed within the drip line of existing trees at any time, or where roots are encountered outside the dripline of the tree.

j. Branches interfering with construction but not designated for removal may be removed only as directed by the Architect.

k. Any pruning, cutting, or trimming of any trees will be performed by an International Society of Arboriculture Certified Arborist or certified tree worker or in accordance with the National Arborist Association and/or International Society of Arboriculture pruning standards. Cutting of 2" diameter limbs or greater or major dead wooding shall require approval of the Architect.

l. Trees or shrubs scheduled to remain and damaged by construction operations shall be repaired by the contractor in a manner acceptable to the Architect. Damaged trees and shrubs shall be repaired promptly to prevent progressive deterioration. Repair or replacement of trees and shrubs shall be at the contractor’s expense as determined by the Architect. Contractor shall be held fully liable for damage caused to trees and shall be assessed fees based on the International Society of Arboriculture “Guide for Plant Appraisal”, as determined by the project Arborist; fees will be assessed for: 1) any injury to the trunk, limbs, or root system, and (2) for the value of any tree requiring removal subsequent to injury or treatment that varies from these Specifications.

m. A permit from the City Arborist may be required prior to pruning or removing any trees, as required by applicable codes or ordinances.

n. Parking of vehicles, equipment or storage of materials under the drip line of existing trees shall not occur at any time.

o. Wash all existing and new trees weekly to remove dust and debris during construction.
1.09 SCHEDULING

A. Within 30 days after the commencement of initial grading, furnish documentation to the Architect that all plant material has been secured for the project and is available. Contractor shall be responsible for payments and deposits required by the grower or plant consultant to secure, maintain, and grow plant material indicated on the Contract Drawings.

1.10 WARRANTY

A. Special Warranty: Warrant all plant material in writing where installer agrees to repair or replace plantings and accessories that fail in materials, workmanship or growth within specified warranty period.

1. Failures include, but not limited to, the following:
   a. Death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, abuse by owner.
   b. Structural failures including plantings falling or blowing over including during high wind events.
   c. Faulty operation of tree stabilization edgings tree grates.
   d. Deterioration of metals, metal finishes and other materials beyond normal weathering.
   e. Material not thriving.
   f. Warranty periods begin from date of final completion:
      1) Trees, vines, shrubs: One year.
      2) Ground cover and turf: One year.

2. Warrant plant material, installed, or relocated under the contract, in writing, for a period of one year (after beginning of maintenance period) against defects including death, and unsatisfactory growth, except for defects resulting from neglect, abuse or damage by others.

3. Remove and replace trees, shrubs or other plants found to be dead, yellowing, defoliating, or in unhealthy condition, or other defective materials during warranty period at no additional cost to the Owner. Replace trees and shrubs, which in the opinion of the Architect, are in unhealthy condition at end of warranty period. The Architect shall be the sole judge as to the condition of the material. All replacement materials and installation shall comply with the drawings and specifications. Another inspection may be conducted at end of warranty period to determine acceptance or rejection.

4. Upon receipt of written notice from Owner of the loss of any warranted plant materials during the warranty period, the subject plant materials shall be promptly replaced with the same species originally planted, and of a size closely approximating the size of the plant, if normal growth had occurred since the original planting. Replacements shall be subject to the requirements of this specification.

5. When plants are replaced, advise the Owner, in writing, of the new establishment maintenance period equal to the one year.

6. Plant material must be replaced within ten (10) days of written notification, and shall be installed in accordance with these specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Design is based on the use of products manufactured by the following.
   1. Best Fertilizer Company, Lathrop, CA
   2. BFI Organics, Milpitas, CA 408-262-1401
4. Delta Bluegrass Co. Stockton, CA (209) 469-7979
5. Horizon, Roseville, CA 916-780-2033.
6. Landscape Forms, represented by Rebecca Casey, 510~594-1777.
7. LH Voss, Dublin, CA 925-560-9920
10. Pacific Coast Seed. 533 Hawthorne Place, Livermore, CA 94551 (925) 373-4417
17. TMT Enterprises, San Jose, CA 408-432-9040.
27. Permaloc Corporation, Holland, MI, 616-399-9600.
29. Wayside Lumber, Rancho Cordova, CA, 916-635-9090.
30. EPIC Plastics, Cerritos, CA, 562-403-3848.
31. Materials shall be the products of one manufacturer and shall be either the ones upon which the design is based, or the products of manufacturer accepted in advance. No substitutions will be permitted.

2.02 SOIL

A. TOPSOIL: Site to be rough graded to elevations shown on Civil Drawings. Topsoil will be required behind curb areas and in planting areas. Provide on-site, import, or non-processed topsoil in planting areas as needed to complete rough grading which is fertile, friable, and natural loam in accordance with Article 2.3. Topsoil shall be from agricultural sources, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 3/4-inch in any dimension, and other extraneous or toxic matter harmful to plant growth.

B. All topsoil to be used for planting, regardless of whether import or on-site in origin, shall be tested as described in Part 3 of this Section.

C. Biofiltration Planter Soil
   1. Pre-manufactured soil as purchased by TMT Enterprises.
      a. The soil shall be a blend of 4 parts by volume washed sport sand to 1 part sandy loam topsoil. The gravel content shall not exceed 15% by weight with the largest allowable particle not exceeding 1/4 inch.
      b. Chemistry:
         1) The pH shall be in the range of 6-8.0.
2) Salinity shall not exceed 3.0 dS/m.
3) Sodium: Sodium absorption ratio (SAR) shall not exceed 5.0
4) Boron shall not exceed 1 ppm.

c. Amendments:
   1) The top 6 inch layer the following shall be uniformly blended by
      means of a pub mill or equal.
      (a) Amount/cubic yard
          (1) 10% by volume of Reed Sedge Peat Moss
          (2) 25% 8X20 Lassenite Pozzolan
          (3) 15 lbs. 6-20-20 fertilizer
          (4) 50 lbs. Gypsum

d. Location(s)
   1) Use in designated infiltration planter areas and bioswale areas,
      see planting plans.
   2) Depth shall be per details.
   3) Available through TMT Enterprises, San Jose, CA
   4) Contact: Matt Moore

2.03 SOIL AMENDMENTS

A. On Grade:
   1. The initial application of fertilizers and amendments to be tilled into
      the soil during soil preparation operations shall be established after soil
      testing has been conducted by Contractor. An estimated quantity is
      indicated below for bid purposes only. This estimated quantity does not
      include mulching, fertilizer tablets, additional topsoil necessary to meet
      specified grades and fertilizer applications for after planting. After soils
      analysis recommendations are made to the Architect quantifying the
      actual amount of amendments required and recommendations have
      been accepted by the Architect, the Contractor shall, without delay,
      determine any cost impacts whether credit, no change, or addition, to
      the Contract Amount. As an integral part of the bid for Landscape
      Work, provide a Lump Sum bid amount for fertilizers and amendments
      as described below.
   2. Application Rates (FOR BID PURPOSES ONLY):
      a. Sixty (60) lbs. of Tri-C Humate per 1,000 square feet.
      b. Nineteen (19) lbs. of 6-20-20 fertilizer per 1,000 square feet.
      c. Six (6) cubic yards of Aguiñaga GPS2, nitrogen stabilized compost
         per 1,000 square feet.
      d. 50-lbs Agricultural Gypsum, per 1,000 square feet.
   3. Pot or Raised Planter Soil Mix: Prepare and backfill pots with a mix of
      the following per cubic yard:
      a. Terravita soil by TMT Enterprises
      b. 12-12-12 Commercial Fertilizer
      c. Organic Amendment - 1/3 cubic yard
      d. Fine Sand - 1/3 cubic yard
      e. 12-12-12 Commercial Fertilizer - 1 pound
      f. Iron Sulfate - 2 pounds
   4. Actual amendment rates and type shall be per soil test
      recommendations.
   5. Imported Topsoil
      a. Provide natural, fertile, friable soil free from stones, noxious weeds,
         seeds, roots, subsoil or other material detrimental to normal plant
         growth. Topsoil acidity range (pH) shall be between 6.5 and 7.5
         containing a minimum of 4 percent and a maximum of 25 percent
         organic matter.
b. Reuse surface soil stockpiled onsite. Verify suitability of stockpiled surface soil to produce top soil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
   1) Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain top soil displaced from naturally well drained sites where topsoil occurs at least 4 inches deep; do not obtain from [agricultural land], bogs or marshes. Obtain soil from local sources acceptable to the Architect.
   2) Silt plus clay content of soil shall not exceed 15 percent by weight with a minimum 95 percent passing a 2 millimeter sieve.

c. Obtain imported topsoil from local sources acceptable to the Architect.

d. Silt plus clay content of soil shall not exceed 15 percent by weight with a minimum 95 percent passing a 2-millimeter sieve.

6. Soil Amendments:
   a. "Nitrified Redwood Compost": 0.56 to 0.84% N based on dry weight, treated with relative form of nitrogen (NH3).
      1) Particle Size
      2) 95% - 100% passing 6.35 mm standard sieve.
      3) 80% - 100% passing 2.33mm standard sieve.
      4) Salinity: The saturation extract conductivity shall not exceed 3.5 millimhos/centimeter at 25 degrees (25N) centigrade as determined by saturation extract method.
      5) Iron Content: Minimum 0.08% dilute acid soluble Fe on dry weight basis.
      6) Ash: 0 - 6.0% (dry weight)
      7) Acidity range (pH) shall be between 5.5 and 7.5.
      8) Actual organic content shall be a minimum 280 pounds (lbs.) per cubic yard.
      9) As available from: Redi-Grow Corporation, 909 Elder Creek Road, Sacramento, CA 95828

   b. Organic soil amendment shall be Aguinaga GPS2.
      1) Particle Size:
         (a) 90-100 percent passing 6.35 mm standard sieve.
         (b) 80-100 percent passing 4.75 mm standard sieve.
      2) Salinity: The saturation extract conductivity shall not exceed 6.5 millimhos/centimeter at 25 degrees Centigrade as determined by saturation extract method.
      3) Iron Content: Minimum 0.08 percent dilute acid soluble iron on dry weight basis.
      4) Actual organic content shall be a minimum of 280 pounds (lbs.) per cubic yard.

7. Fertilizers
   a. Tri-C Humate. Provide per manufacturers specification.

   b. Fertilizer Tablets: Fertilizer Tablets: The following is to be used in the planting of container grown material. Follow manufacturer's application rates.
      1) Best-Paks "20-10-5" fertilizer packets. Packets to be made up of a minimum of 20% Nitrogen, 10% Phosphorus, 5% Potash. Use 1 Pak per 1-gallon container, (G.C.), 3 Paks per 5 G.C., 9 Paks per 15 G.C. and 12 Paks per boxed specimen. Evenly distribute as shown in details.

d. Related Materials:
   1) Pre-Planting Herbicide: Round-up, or equal.
   2) Pre-Emergent Weed Control: Ronstar-G, Treflan, Eptam, Vegitex, or equal.
   4) Peat Moss: Sphagnum peat moss, Canadian or European variety, free from alkali.
   5) Soil Sulfur: First quality commercial grade.
   6) Ferrous Iron Sulfate: Chelated first quality commercial grade.
   7) Agricultural Gypsum: First quality commercial grade.
   8) Best "Ammonium Phosphate" 16-20-0 with net less than 16% total nitrogen, 20% available phosphoric acid and 0% soluble potash.
   9) Good Humus.
   10) Root Hormone: Super Thrive.

2.04 PLANT MATERIALS

A. Quality: Provide trees, shrubs, and other plants of size, form, genus, species and variety shown and scheduled for landscape work and complying with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock".

B. Deciduous Trees: Provide trees of height and caliper scheduled or shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Provide single stem trees except where special forms are shown or listed.
   1. Lateral scaffolds shall be radially distributed around the trunk. The lateral branch shall be no more than 2/3 the diameter of the trunk. Trunk to be measured 1" above the branch (lateral scaffold).
   2. The minimum acceptable length of the most recent season's shoot growth for slow growing trees shall be not less than 8"; for fast growing trees not less than 12".
   3. The minimum acceptable height of trees is 6'-0" when planted, or as determined by Architect.
   4. Needle Leafed and Broad Leafed Evergreen Trees: Provide evergreens of sizes shown or listed. Where dimensions are shown, they indicate minimum spread for spreading and semi-spreading type evergreens and height for other types, such as globe, dwarf, cone, pyramidal, broad upright, and columnar. Provide normal quality evergreens with well-balanced form complying with requirements for other size relationships to the primary dimension shown.
      a. The minimum acceptable height of trees is 6'-0" when planted, or as determined by Architect.
   5. Multi-Trunk Trees: Provide sizes shown or listed. Tree is to have a minimum of three (3) dominant trunks with appropriate caliper size and adequate spread.
   6. Shrubs: Provide shrubs of the size shown and with not less than the minimum number of canes required by ANSI Z60.1 for type of shrub required. Provide container grown stock.
   7. Ground Cover: Provide plants established and well-rooted in removable containers, in flats, or integral peat pots and with not less than
minimum number and length of runners required by ANSI Z60.1 for the size shown or listed.

8. Vines: Provide vines with good, well-established root systems within the container, and devoid of any abrasions, and or damage to stem.

2.05 SOD

A. Lawn Sod:
1. Nursery-grown sod shall have the following characteristics:
   a. Sod for planting areas shall be dense, healthy, field-grown on sand fumigated soil with the grass having been mowed at 1-inch height before lifting from field.
   b. Sod for grass pave areas shall be dense and healthy, grown on a sand bed thin cut and washed.
   c. Sod shall be dark green in color, relatively free of thatch, free from disease, weeds and harmful insects.
   d. Sod shall be reasonably free of objectionable grassy and broadleaf weeds. Sod shall be considered weed free if no more than 2 such weeds are found per 100 square feet of sod.
   e. Sod shall be rejected if found to contain the following weeds: common Bermuda grass, quack grass, Johnson grass, nimble weed, thistle, bindweed, bentgrass, perennial sorrel, and bromegrass.
   f. Sod variety shall be:
      1) Turf Grass: Tiffway II, Bullseye, Bandera, GN1, Medallion Plus 90% Tall Fescue/10% Bluegrass Blend, as produced by West Coast Turf / Pacific Sod.
      2) Native Preservation Mix by Delta Bluegrass.

2. Lawn Seed:
   a. Turf Grass: Seed mix shall consist of 90% Shortstop II Dwarf Fescue and 10% Nustar Kentucky Bluegrass at the rate of 523 lbs./acre.
   b. Fertilizer: Combination of 16-20-20 and "Endure" 15-15-15 at a rate of 5 lbs./sf.
   c. Fiber: Hydro blanket at 60 lbs./1,000sf.
   d. As indicated on Contract Drawings.

3. Stolons
   a. Tiffway II - as produced by West Coast Turf.
   b. Bullseye - as produced by West Coast Turf.
   c. Bandera - as produced by West Coast Turf.
   d. GN1 - as produced by West Coast Turf.
   e. Medallion Plus - as produced by Pacific Sod.
   f. No mow Fine Fescue - as produced by Delta Bluegrass.
   g. Furnish binder, fertilizer and amendments per soils report and stolon manufacturing recommendations.

2.06 MISCELLANEOUS LANDSCAPE MATERIALS:

A. Tree Grates
   1. Tree Grates and Frames: ASTM A 48/A 48M, Class 35 (Class 250) or better, gray-iron castings and ASTM A 36/A 36M steel-angle frames of shape, pattern, and size indicated; steel frames hot-dip galvanized.
   2. Shape and Size: As indicated on drawings.
   3. Finish: Polyurethane finish or Powder-coat finish.
   4. Color: As indicated on drawings, Low-gloss black.

B. Tree Stakes: Provide stakes of sound new lodgepole pine 2" minimum diameter with minimum height, as indicated on Contract Drawings. Stakes
shall have been treated with copper napthanate or ACQ (alkaline) or Ca-B (copper azole) to a minimum wood depth of 1/16". All stakes shall be free of knots larger then 1/2" in diameter, holes and other defects.

C. Tree Straps: Provide VIT "Cinch-tie" black tree straps. Tree straps shall be attached to tree stake as shown in staking detail on the plans, color to be black.
1. Provide for 24-inch box size and smaller tree.
2. 36-inch box size and larger tree; provide VIT "Cinch-Belt" tree straps.

D. Vine Ties: Plastic vine ties, as specified on plans.

E. Guying Materials
1. At On-Grade Planting:
   a. Guy Wire: No. 9 gage, galvanized, twisted clothesline type.
   b. Anchor System: Duckbill Earth Anchor System, as manufactured by Fore Site Products, Inc.
      1) Box trees, sizes 24-inch box to 72-inch box: Model 68 DTS.
      2) Box trees, sizes 84-inch and larger: Model 88 DTS.
   c. Hose: White neoprene hose, 3/4-inch diameter, covering the entire length of wire.
2. At Raised Planters:
   a. Guy Wire: No 9 gage, galvanized, twisted clothesline type.
   b. Anchors for Holding Guys: 1-inch galvanized eyebolt with lead expansion shield.
   c. Hose: White neoprene hose, 3/4-inch diameter, covering the entire length of wire.
3. Turnbuckle: 51/16 inches by 6 inches long galvanized steel type.
4. At Tree Grates
   a. Guy Wire: No. 9 gage, galvanized, twisted clothesline type.
   b. Anchor System: Duckbill Earth Anchor System, as manufactured by Fore Site Products, Inc.
      1) Box trees, sizes 24-inch box to 72-inch box: Model 68 DTS.
      2) Box trees, sizes 84-inch and larger: Model 88 RBK

F. Headerboards And Edging
1. Wood Polymer Headerboard:
   a. All wood used shall be "Trex" or "EPIC Plastics" wood-polymer lumber.
   b. Headerboards shall be:
      2" x 6" (for straight runs and smooth curves)
   c. Splices shall be made with 1" x 6" not less than 12" in length.
   d. Stakes shall be made with 1" x 3" x 16" or 1" x 2" x 18".
   e. 1¼", #8 plated deck screws.
   f. Refer to manufacturer's literature for product handling and installation.
   g. Backing at splices, 1" x 4".
2. Concrete edger: Dimension as specified on plans, poured in place concrete edger, color per plan.
3. Steel Edge Restraint for Decomposed Granite Walk or Landscape Areas: Available Manufacturers and Products: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
   a. Pave Tech, Inc.
   b. J.T. Ryerson & Son, Inc. Or equal (no known equal).
      1) Material: Steel.
2) Size: 1/4" x 5".
3) Color: Black.
4) Stakes: 4 foot maximum spacing.
5) Wood: Rough construction heart redwood, 12-foot minimum length, free from knots and splits. Provide 2 by 4 for straight sections and three laminations of ¼-inch material for curved sections.
6) Stakes: 1 by 2 by 18-inch construction heart redwood, bevel cut.
7) Scabs: 1 by 4 by 4-feet long construction heart redwood.
8) Nails: Common, galvanized, 16d.
9) Splices: 1 by 4 by minimum 24-inches long.

4. Aluminum Edge Restraint for Decomposed Granite Walk or Landscape Areas:
   a. Cleanline as manufactured by Permaloc Corporation.
   1) Color and Finish: Black anodized finish.
   2) Stakes: 12 inch long aluminum

G. Mulch
   1. River Cobble Mulch: Washed River Cobble blend consisting of 3-8" diameter cobbles. Place 8 inch minimum depth and extend 6" either side beyond weed control fabric edge.
   2. Rock Mulch: As indicated on drawings. All 3/8-inch "Birds Eye" aggregate rock mulch shall be washed twice by Contractor and shall be clean prior to installation.
   3. Bark Mulch:
      a. Mulch shall be "small" fir bark mulch, as manufactured by Whittier Fertilizer.
      b. Mulch shall consist of "walk-on" fir bark mulch with a particle range of 13/4-inch to 1-inch in diameter. (Shredded bark is not acceptable).
      1) Physical properties:
         (a) Percent Passing Sieve Size
         (b) 90-100 1 inch (25.4 mm) Dia.
         (c) 80-100 1/2 inch (12.7 mm) Dia.
         (d) 20-60 1/4 inch (6.35 mm) Dia.
      2) Chemistry
         (a) Acid in reaction, max pH 5.0.
         (b) Maximum ash Chemistry: 7% based on dry weight.
         (c) Minimum moisture 35% at time of delivery based on fresh weight.
      3) As available from Redi-Grow Corporation, Sacramento, CA.

H. Weed Control Fabric: Place Mirafi Mirascape landscape fabric below rock mulch or as shown on drawings. Overlap all seams 12" minimum and pin down every 36" typical. Mirascape fabric available from: Towns & Associates, 800-222-6036

I. Root Control Barriers: High-density polyproylene root control planter. Acceptable products include:
   1. Deep Root; Deep Root Corporation.
   2. Size as specified on drawings.

J. Drainage Materials
   1. Gravel in raised planters on structural slab and in pots shall be clean, coarse 3/8-inch to 3/4-inch diameter.
   2. Gravel for tree drainage shall be 3/4" diameter coarse clean gravel.
3. Synthetic filter membrane cover over drainage course shall be woven synthetic fabrics.
   a. Model 140N, as manufactured by Mirafi.
4. Drain Pipe at trees: 4-inch diameter PVC perforated(within gravel), and non-perforated PVC drain pipe(stand pipe) with PVC adaptor connected to 4-inch ABS female receiver with 4-inch black ABS cleanout plug.

K. Sand: Washed plaster sand.
L. Jute Netting: A uniform open plan weave, single jute yarn not varying in thickness by more than 1/2 of its normal diameter, in rolled strips approximately 50 to 75 yards long and 50 to 60 inches wide. Contractor shall submit sample for approval prior to installation.
M. Staples: 11 gage with 1-inch top and 6-inch legs.
N. Sod Pegs: 1-inch square by 6-inch long pine or 6-inch lengths of lath.
O. Weed Control: Round-up, Rodeo, or equal.

P. Landscape Drainage System:
   1. Catch Basin: NDS Model #1200 12x12 catch basin; black color with NDS #1217 riser extension as necessary.
   2. Grate: NDS Model #1290 atrium grate in planter area, NDS Model #1211 in turf area; black color.
   3. Outlet adapter: NDS Model #1266 universal outlet; as necessary. NDS Model #1206 universal plug; as necessary.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected, and Architect has reviewed and accepted materials as defined within the section.

3.02 SITE OBSERVATION SCHEDULE

A. General: Notify Architect at least 5 days in advance when requesting on-site reviews.
B. Prior to commencement of site visits, items noted in previous observation reports shall have been either completed or remedied, unless such compliance has been waived. Failure to complete prior tasks or failure to prepare adequately for scheduled observations shall obligate Contractor to reimburse Architect for additional hourly services, plus transportation costs
C. Schedule For On-Site Reviews by the Landscape Architect:
   1. Pre-construction conference with general contractor, grading contractor, landscape contractor, project arborist and landscape architect to discuss grading and protective measures to be followed in the vicinity of existing trees, or existing structures.
   2. Review of soil sampling and fine grading prior to installation of any planting material.
   3. At completion of finish grading, and roto-tilling
4. Review of irrigation coverage prior to installation of any planting material.
5. At completion of fine grading and at delivery of plant materials, together with plant layout; prior to excavating pits.
6. Review of drainage system, standpipes, and plant material locations.
7. After planting pits have been excavated, but prior to backfilling. Provide one sample plant pit mock up for review.
8. After initial planting operations (One tree with each type of specified staking shall be approved prior to planting of trees).
9. Stake all tree locations for review.
10. See "Final Review and Acceptance" at the end of Part 3 in this Section for final site observations and acceptance of work.

3.03 TESTING

A. Planting Soil: Agronomic Soil Testing
   1. Test shall be paid for by the Contractor. Testing lab shall be:
      a. Wallace Labs, El Segundo, CA
      b. Soil and Plant Labs, Orange, CA
      c. Sunland Analytical Labs, Rancho Cordova, CA
      d. Soil & Plant Lab, Santa Clara, CA
      e. Agronomic Soils Testing
         1) Take six samples of site soil at a depth of 6 to 12 inches, within proposed planting areas, after completion of final grading and prior to weed control and soil preparation.
         2) Take samples to agronomic soils testing laboratory indicated above for soil evaluation.
         3) Request testing for fertility and suitability analysis with written recommendations for soil amendment, fertilizer and chemical conditioners, application rates for soil preparation, planting backfill mix, pot-soil mix, hydro-spray, and post-maintenance fertilization programs.
         4) Soils report recommendations shall take precedence over the amendment and fertilizer application rates specified in this section.
         5) Submit testing laboratory's interpretation, recommendations, and comments to Architect within 14 days after the completion of rough grading.
      f. Furnish a soils analysis of import soil, and organic soil amendment prior to backfill.
         1) Submit soil testing laboratory's findings to Architect within 5 days prior to backfilling.
      g. Take six additional soil samples after completion of planting in the soil preparation and backfill mix areas, to be determine effectiveness to amendments prior and during planting. Submit to the testing laboratory the original amendment specification with previously issued bulletins for soil amendments and installation procedures. Re-apply necessary amendments based on recommendation of new soils test.

3.04 PREPARATION

A. Final Grades
   1. Finished grading shall insure proper drainage of the site. Conform to Division 31 Section "Earthwork" and Division 32 Section "Finish Grading."
2. The following areas shall be graded so that the final grades shall be established below adjacent paved areas, sidewalks, valve boxes, headers, clean outs, drains, manholes, etc. before placement of mulch as follows:
   b. Turf areas: 1-inch.
   c. Surface drainage shall be away from all building foundations, 2% minimum.
   d. Dispose of excess or unacceptable soil from the site at no expense to the Owner.
   e. Verify that final grades have been established prior to beginning planting operations.

3. Parking Lot Planters and areas adjacent to hardscape.
   a. All aggregate base rock, lime-treated soil, soil sterilents, and other non-organic materials shall be removed from all parking lot planter areas down to the level of native soil. Scarify native soil to a depth of 12 inches and backfill planters to specified finish grade with native or approved topsoil and amend as specified.
   b. Remove all concrete overpours or any material that may prohibit the placement of plant material, irrigation, grates, root barriers, or any other conflicting material.

4. Lightweight soil mix shall be sampled after mixing and delivery to the site, but prior to filling planters. Submit the original lightweight soil specification to the testing laboratory with previous bulletins for lightweight soil mix. Provide 1-quart of lightweight soil mix for every 65 cubic yards for organic and fertility analyses. Fertility analysis, recommendations and interpretations shall be furnished by the testing laboratory to ensure all specified amendments have been provided. Lightweight soil is to be used only in locations indicated on the Contract Drawings and as approved by the Architect.

5. Protect planting areas from compaction by foot, trucks and heavy equipment.

3.05 PLANTING BED ESTABLISHMENT

A. Preparation Of Planting Area
   1. Cross-rip on-grade planting areas to a minimum depth of 12 inches minimum 2 perpendicular directions. Remove stones over ½ inch (13mm) in any dimension and sticks, roots, rubbish and other deleterious matter per Section 02312 "Finish Grading".
   2. Where additional soil is needed, place the top 15” with topsoil. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil.
   3. Leach soil prior to amending.
   4. After approximate finished grades have been established and soil has been leached, soil shall be conditioned and fertilized in the following manner: Soil condition shall, at the rate specified in the approved soils test recommendations, be uniformly spread and cultivated thoroughly by means of mechanical tiller into the top eight inches (6”) of soil.
   5. Broadcast soil amendments uniformly over surface of the area to be treated. Roto-till the top eight inches (6”) of planting areas to evenly distribute the amendments and conditioners into the soil.
   6. Retest as required to verify leaching was successful. All soil areas shall be compacted and settled by application of irrigation to a minimum depth of six (6) inches prior to any plant materials being installed.
7. At time of planting, the top 12 inches of all areas to be planted shall be free of stones, stumps, or other deleterious matter one 1/2 inch in diameter or larger, and shall be free from all debris, or similar objects that would be a hindrance to planting and maintenance.

8. Pre-emergent Weed Control: Immediately after planting, apply pre-emergent weed control to planted areas which will not be seeded.

9. Excavation For Trees And Shrubs
   a. Excavate pits, beds, and trenches as shown in details on the drawings.

10. Preparation for Lawn Areas: Limit preparation to areas which will be planted promptly after preparation.
    a. Prepare planting area as described in 3.05 A.
    b. Fine grade lawn areas to smooth, even surface with loose, uniformly fine texture. Roll, rake and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Establish smooth uniform surface. Limit fine grading to areas which can be planted immediately after grading.
    c. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

11. Restore lawn areas to specified conditions if eroded or otherwise disturbed after fine grading and prior to planting.

3.06 BIOFILTRATION PLANTER SOIL
   A. The Biofiltration planter soil shall be placed on the planter area and firmed to a depth of as shown on the drawings. Mix shall be moist when spread to discourage migration in to the subgrade and to assist forming.
   B. Soil mix shall be separated from drainage courses with geotextile fabric equal to Mirafi 140N.
   C. See Grading Plans for locations and depths and Planting plans for plant material.

3.07 ROOTZONE FOR SAND BASED TURF
   A. The thoroughly mixed root zone material shall be placed on the areas designated for turf (except for areas designated for grass pavers) and firmed to a uniform depth of 6 inches (300mm) with a tolerance of +1/4-inch (6mm). Mix shall be moist when spread to discourage migration in to the subgrade and to assist forming.
   B. Soil mix shall be separated from drainage courses with geotextile fabric equal to Mirafi 140N.
   C. See Planting Plans for turf locations.

3.08 JUTE MESH
   A. Make check slots before the netting is rolled out. Dig a narrow trench across the slope perpendicular to the direction of the flow. Fold jute, the same length as the trench, and press together. Location of check slots shall be a maximum of 50 feet apart.
   B. Installation: Roll netting parallel to slope contours. The netting shall completely cover all areas as indicated on Contract Drawings. Overlaps shall be ample and well stapled.
   1. Lay netting smoothly, and in continuous contact with the soil surface at all points.
2. Install without stretching. Where one roll of netting ends and a second roll starts, the up slope piece shall be brought over the buried end of the second roll so that there is a 12-inch overlap. Where two or more widths of netting are applied, side by side, the overlap shall be not less than 3 inches.

3. Staple overlapping edges that run parallel to the direction of the flow at 2-inch intervals. Outside edges, centers, and overlaps on banks shall be stapled across the slope at 6-inch intervals.

4. Top dress jute netting area with a thin layer of topsoil. After the top dressing, the yarns shall still be visible.

5. Spread loose topsoils over outside edges of netting to allow for smooth entry of water.

6. Clods that hold the jute off the ground shall be stamped into the soil. Force jute netting down into depressions and hold there with a staple.

7. Install plant material through netting.

8. Maintenance: Maintain jute netting until work on the Project has been completed and accepted and during the 90-day maintenance period. Maintenance shall consist of the repair of eroded areas and the repair or replacement and re-stapling of loose or undermined netting. Replace damaged planting materials as required.

9. Install jute netting in all areas of 30 percent slope or greater.

3.09 SOD

A. Sod shall be laid with closely fitted joints on a smooth, level surface which has been prepared as previously specified. Ends of strips shall be staggered. On irregular areas, sod shall be laid in both directions from the longest straight line that can be drawn through the area.

B. After a light initial watering immediately after installation, the sod shall be rolled to eliminate all irregularities.

C. After compaction, the sodded area shall be wetted to a soil depth of at least 8 inches.

D. Sod shall be as specified on the Contract Drawings

E. Protect sod from pedestrian traffic for 21 days and from sports activity for 6 weeks.

F. Sod is to be rolled minimum two times or as often as required in two directions with a water ballast roller to remove variations in grade. Sand infill all depresses. Sand to comply with turf manufacturer recommendations.

G. Sod is to be machine placed from “Big Rolls”.

3.10 PLANTING

A. General

1. Actual planting shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted practice, as approved by the Architect.

2. Only as many plants as can be planted and watered on that same day shall be distributed in a planting area.

3. Container shall be opened and plants shall be removed in such a manner that the ball of earth surrounding the roots is not broken and they shall be planted and watered as herein specified immediately after removal from the containers. Containers shall not be opened prior to placing the plants in the planting area.
B. Layout individual tree and shrub locations and areas for multiple plantings. Stake locations and outline areas and secure acceptance by the Architect before start of planting work. Make minor adjustments as may be requested.

C. Excavation for Trees and Shrubs:
   1. Excavate pits, beds and trenches as shown in details on the Drawings.
   2. Roughen and score edges of planting pit to eliminate any glazing of the sides of the pit.
   3. Field Samples: Prior to planting, prepare one plant pit with standpipe, gravel, filter fabric, and root barriers for each tree size to be reviewed by the Architect.
   4. Do not cover standpipes.
   5. Excavation for planting shall include the stripping and stockpiling of all acceptable topsoil encountered within the areas to be excavated for trenches, tree pits, plant pits, and planting beds.

D. Container Removal
   1. Cut containers on two sides with an acceptable cutter. Do not cut containers with spade or ax. Do not injure the rootball.
   2. Carefully remove plants from containers without injury or damage to rootball.
   3. After removing plants, superficially cut edge roots with knife on three sides.
   4. For plants with sensitive roots, place container intact in flat pit 1½ times the size of a standard plant pit. Insert blades of sharp, needle-nose shears into a drain hole and cut the container bottom away. Remove bottom from pit. Follow with a cut down one side of the container from top to bottom. Repeat cut on opposite side. Fill plant pit with prepared plant pit mixture. Carefully remove the detached pieces.

E. Box Removal:
   1. Remove bottom of planting boxes before planting.
   2. Remove sides of box without damage to rootball after positioning plant and partially backfilling.

F. Planting Trees and Shrubs: Set container-grown stock, plumb and in center of pit or trench. Set top of rootball 2-inches above finish grade at trees, 1-inch above finish grade at shrubs, or as indicated on Contract Drawings. Do not use plant, if root system has severely kinked or circling roots, or if rootball is cracked, disturbed or broken. If root system is healthy, loosen spiraling roots and set in plant pit.

G. Planting pit shall be backfilled with the following soil conditioner and organic amendment, per cubic yard:
   1. Application Rates, (below are for bid purposes only) as determined by contractor's soils tests:
      a. Potassium Sulfate - 0-0-50, ¼-pound
      b. Single Superphosphate - 0-20-0, ¼-pound
      c. Ammonium Sulfate - 21-0-0, ¼-pound
      d. Compost - 15% by volume
      e. Agricultural Gypsum - 1.5 pounds
      f. Good Humus - 15% by volume
   2. Final amendments to be determined by Agronomic Soils Test.
H. When set, place additional fill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 1/2-full, place appropriate number of fertilizer tablets and complete backfill operations.

I. After backfilling, an earthen basin shall be constructed around each plant. Each basin shall be as indicated on the Contract Drawings. Basin shall be of a size suitable for the individual plant. In no case shall the basin for fifteen (15) gallon plant be less than four (4) feet in diameter; a five (5) gallon plant less than three (3) feet in diameter. The basins shall be constructed of amended backfill materials, and shall not be constructed for trees in turf areas.

J. Repeat watering until no more is absorbed.

K. Apply pre-emergent herbicide as per manufacturer’s recommendations to all shrub and ground cover planting areas after planting.

L. Mulch all planted areas that do not receive jute netting, other than lawn areas, at not less than 2" thickness of mulch.
   1. Areas greater than 30% slope shall be protected with jute mesh.

M. Equally space and align trees and shrubs in both directions where designated on Contract Drawings.

N. Pull bark mulch away from the rootballs of all plants to insure proper air circulation.

O. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practices. Prune trees and other plantings only if required. Pruning shall be limited to remove injured wigs and branches, and to compensate for loss of roots during transplanting, but never exceed 1/3 of the branch structure. Never prune without prior review with Architect.

P. Prune shrubs to retain natural character. Unless directed by the Architect, do not prune leaders or apices of any plant material. Do not prune into balled or boxed forms without prior written approval of the Architect.

Q. Remove and replace excessively pruned or malformed stock resulting from improper pruning.

R. Planting Ground Cover
   1. Space plants as shown or scheduled.
   2. Dig holes large enough to allow for spreading of roots and compact area around plant. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water. Water thoroughly after planting, taking care not to cover crowns of plants with wet soils.
   3. Mulch areas between ground cover plants with not less than 2" deep mulch.

S. Miscellaneous Landscape Work: Install headers and edgings where shown. See appropriate details. Install 5" minimum layer of gravel, where shown, as specified in Section 2.04, compacted and leveled to fill voids at areas around building as shown on drawings.

T. Planting Vines: Plant in accordance with Section 3.06. Attach vine to columns with vine ties as per manufacturer’s recommendations.
U. Tree Staking and Guying: Stake or guy all trees per landscape details, and tie with tree ties as specified. Remove all nursery stakes from trees unless directed otherwise by the Architect. Immediately after planting, stake and guy all trees in accordance with details indicated on Contract Drawings. One tree of each size shall be staked and guyed, and reviewed by Architect prior to continue work.

V. Hardpan Conditions
1. Where hardpan exists, whether it is in the form of caliche, rock or other impervious matter, and it is within the top 2½ feet of soil, or within the plant pit, use powered equipment to break through completely at each plant location to allow drainage and root growth. Remove hardpan at least 1½ feet greater than the rootball diameter of plant. Backfill with soil mix as specified.
2. Where hardpan is within the first 12-inches of soil, it shall be completely penetrated for all trees and shrubs.

3.11 CLEANUP AND PROTECTION:
A. During landscape work, keep pavements clean and work area in an orderly condition. Haul away and remove all debris from landscape areas, and do not leave any clippings, and or other material from landscape planting and/or maintenance period.
B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and/or other trades. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.
C. Powerwash all pavement and flatwork as necessary to remove all staining and tire marks and provide a clean surface.

3.12 FINAL REVIEW & ACCEPTANCE
A. General: Notify Architect at least 5 days in advance when requesting on-site reviews.
B. Final Site Observation requirements:
   1. Punch list at substantial completion.
   2. Final review of grading, irrigation and planting (to begin Maintenance Period).
   3. Final acceptance of project (at end of Maintenance Period).
   4. Refer to Division 32 Section "Landscape Maintenance."
   5. The maintenance period will not begin until all punchlist items are resolved and acceptance is provided by the architect in writing.
   6. Where observed work does not comply with the Plans and Specifications, replace rejected work and continue specified maintenance period until reinspected by the Landscape Architect and determined to be acceptable. All replacement materials and installations shall be in accordance with the Plans and Specifications. Remove rejected work and materials immediately from project. Prior to the date of final observation, Contractor shall provide the Landscape Architect with all Record Drawings in accordance with the Plans and Specifications.

3.13 GUARANTEE AND REPLACEMENT
A. Guarantee: All plant material and other materials installed under the Contract shall be guaranteed against any and all poor, inadequate or
inferior materials and/or workmanship or improper maintenance, as determined by the Landscape Architect, and shall be replaced by the Contractor at his expense. Warranty periods are as follows:

1. Trees, vines, and shrubs: One Year
2. Groundcover and Turf: One Year
3. Replacement: Any materials found to be dead, missing, or not in a satisfactory or healthy condition during the maintenance period shall be replaced immediately. The Landscape Architect shall be sole judge as to the condition of material. Material to be replaced within the guarantee period shall be replaced by the Contractor within five (5) days of written notification by the Landscape Architect. All replacement materials and installations shall comply with the Plans and Specifications. Any plant missing due to suspected theft shall be replaced by the Contractor. If the Contractor suspects that theft may be a problem, the Contractor shall provide written documentation to the Landscape Architect that security on this site needs to be intensified.
4. The Contractor may relieve himself of theft responsibility if after the security notice, with no result, a written notice to the Landscape Architect shall be given that plant material will not be replaced for theft or vandalism due to lack of site security being maintained. This procedure may take place only during the Landscape Maintenance Period.

END OF SECTION 32 93 00
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Modular precast concrete manhole sections with tongue-and-groove joints, covers, anchorage, and accessories.

1.02 REFERENCE STANDARDS
   F. Standard Specifications for Public Works Construction (Greenbook); current edition.

1.03 SUBMITTALS
   A. See Section 01 3300 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.05 FIELD CONDITIONS
   A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 MATERIALS
   B. Mortar and Grout: Type S
C. Reinforcement: In accordance with ASTM A615/A615M for reinforcing steel, Grade 60 (60,000 psi), and ASTM A1064/A1064M for welded wire fabric, galvanized, plain type.

**2.02 CONFIGURATION**

A. Shaft Construction: Concentric with concentric cone top section; lipped male/female dry joints; sleeved to receive pipe sections.

B. Shape: Cylindrical.

C. Clear Inside Dimensions: As indicated.

D. Design Depth: As indicated.

E. Clear Lid Opening: As indicated.

F. Steps: 14 inches wide, 16 inches on center vertically, set into manhole wall.

G. Steps: As required by code.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify items provided by other sections of Work are properly sized and located.

B. Verify that built-in items are in proper location, and ready for roughing into Work.

C. Verify excavation for manholes is correct.

**3.02 PREPARATION**

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

**3.03 MANHOLES**

A. Place concrete base pad, trowel top surface level.

B. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.

C. Form and place manhole cylinder plumb and level, to correct dimensions and elevations. As work progresses, build in fabricated metal items.

D. Cut and fit for pipe, conduit, and sleeves.

E. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.

F. Set cover frames and covers level without tipping, to correct elevations.

G. Coordinate with other sections of work to provide correct size, shape, and location.

**END OF SECTION 33 05 13**
SECTION 33 11 16

SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe and fittings for site water lines including domestic water lines and fire water lines.

B. Valves.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for thrust restraints.

B. Section 09 91 13 - Exterior Painting.


D. Section 31 23 23 - Fill: Bedding and backfilling.

E. Section 33 05 13 - Manholes and Structures.

F. Section 33 13 00 - Disinfecting of Water Utility Distribution: Disinfection of site service utility water piping.

G. City of Pittsurg Standard Details and Specifications.

1.03 REFERENCES

A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.


I. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.

J. AWWA C504 - Rubber-Seated Butterfly Valves 3 In. (75 mm) Through 72 In. (1,800 mm); 2010.

K. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS; 2011.

L. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2009.
M. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution; 2007.

N. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service; 2008.

1.04 SUBMITTALS

A. See Section 01 3300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with utility company requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 WATER PIPE

A. Ductile Iron Pipe: AWWA C151:
   1. Fittings: Ductile iron, standard thickness.

B. Copper Tubing: ASTM B88, Type K, annealed:
   2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.

C. PVC Pipe (4" to 12"): AWWA C900 DR 18 (Class 150) and DR 14 (Class 200).
   1. Fittings: AWWA C111/A21.11, cast iron.

D. HDPE Pipe (1/2" to 3"): AWWA C901 DR 11 (Class 200).
   1. Fittings: AWWA C901, molded or fabricated.
   2. Joints: Butt fusion.

E. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

2.02 VALVES

A. Valves: All valves and fittings shall be lead free. Manufacturer’s name and pressure rating marked on valve body.

B. Ball Valves Up To 2 Inches (50 mm):
   1. Brass body, Teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA inlet end, compression outlet with electrical ground connector, with control rod, valve key, and extension box.

C. Swing Check Valves From 2 Inches to 24 Inches (50 mm to 600 mm):
   1. AWWA C508, iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.
D. Butterfly Valves From 2 Inches to 24 Inches (50 mm to 600 mm):
   1. AWWA C504, iron body, bronze disc, resilient replaceable seat, water or lug ends, ten position lever handle.

2.03 BEDDING AND COVER MATERIALS
   A. Bedding: As specified in Section 31 23 16.13.
   B. Cover: As specified in Section 31 23 16.13.

2.04 ACCESSORIES
   A. Concrete for Thrust Blocks: Portland cement concrete per ASTM C150, Type II/V.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Prior to beginning work, verify that building service connection and municipal and site water main size, location, and invert are as indicated.

3.02 PREPARATION
   A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
   B. Remove scale and dirt on inside and outside before assembly.
   C. Prepare pipe connections to equipment with flanges or unions.

3.03 TRENCHING
   A. See the section on trenching for additional requirements.
   B. Hand trim excavation for accurate placement of pipe to elevations indicated.
   C. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide thrust restraint bearing on subsoil, size as indicated.
   D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPE
   A. Maintain separation of water main from sewer piping in accordance with local code.
   B. Install pipe to indicated elevation to within tolerance of 5/8 inches (20 mm).
   C. Install ductile iron piping and fittings to AWWA C600.
   D. Route pipe in straight line.
   E. Install pipe to allow for expansion and contraction without stressing pipe or joints.
   F. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 23 16.13.

3.05 INSTALLATION - VALVES
   A. Set valves on solid bearing.
B. Center and plumb valve box over valve. Set box cover flush with finished grade.

3.06 SERVICE CONNECTIONS

A. Provide water service to utility company requirements with reduced pressure backflow preventer and water meter with bypass valves and sand strainer.

3.07 FIELD QUALITY CONTROL

A. Pressure test water piping as required by the local water agency.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION 33 11 16
SECTION 33 13 00

DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Disinfection of site domestic water lines and site fire water lines specified in Section 33 11 16.

B. Testing and reporting results.

1.02  RELATED REQUIREMENTS

A. Section 33 11 16 - Site Water Utility Distribution Piping.

1.03  REFERENCE STANDARDS

A. AWWA B300 - Hypochlorites; 2011.

B. AWWA B301 - Liquid Chlorine; 2010.

C. AWWA B302 - Ammonium Sulfate; 2010.

D. AWWA B303 - Sodium Chlorite; 2010.

E. AWWA C651 - Disinfecting Water Mains; 2005.

1.04  SUBMITTALS

A. See Section 01 3300 - Administrative Requirements, for submittal procedures.

B. Test Reports: Indicate results comparative to specified requirements.

C. Disinfection report:
   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and time of completion.
   3. Test locations.
   4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
   5. Date and time of flushing start and completion.
   6. Disinfectant residual after flushing in ppm for each outlet tested.

D. Bacteriological report:
   1. Date issued, project name, and testing laboratory name, address, and telephone number.
   2. Time and date of water sample collection.
   3. Name of person collecting samples.
   4. Test locations.
   5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
   6. Coliform bacteria test results for each outlet tested.
   7. Certification that water conforms, or fails to conform, to bacterial standards of State of California.

1.05  QUALITY ASSURANCE

A. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of the State in which the Project is located.
PART 2 PRODUCTS

2.01 DISINFECTION CHEMICALS

A. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine, AWWA B302, Ammonium Sulfate, and AWWA B303, Sodium Chlorite.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping system and water well has been cleaned, inspected, and pressure tested.

B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

3.02 DISINFECTION

A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.

B. Provide and attach equipment required to perform the work.

C. Introduce treatment into piping system.

D. Maintain disinfectant in system for 24 hours.

E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.

F. Replace permanent system devices removed for disinfection.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00.

B. Test samples in accordance with AWWA C651.

END OF SECTION 33 13 00
SECTION 33 31 11

SITE SANITARY UTILITY SEWERAGE PIPING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories.
B. Connection of building sanitary drainage system to private sanitary sewer mains.

1.02  RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.
B. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
C. Section 31 23 23 - Fill: Bedding and backfilling.
D. Section 33 05 13 - Manholes and Structures.

1.03  DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04  REFERENCE STANDARDS


1.05  SUBMITTALS

A. See Section 01 3300 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating pipe, pipe accessories.
C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

PART 2  PRODUCTS

2.01  SEWER PIPE MATERIALS

A. Provide products that comply with applicable code(s).
B. Plastic Pipe: ASTM D3034, SDR 35, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter as indicated, bell and spigot style rubber gasket joints.

C. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.02 PIPE ACCESSORIES

A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.

2.03 BEDDING AND COVER MATERIALS


PART 3 EXECUTION

3.01 GENERAL

A. Perform work in accordance with applicable code(s).

3.02 EXAMINATION

A. Prior to beginning work, verify that building service connections, municipal and site storm main size, location, and invert are as indicated.

3.03 TRENCHING

A. See Section 31 23 16.13 for additional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer’s instructions. Seal watertight.
   1. Plastic Pipe: Also comply with ASTM D2321.

C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

D. Connect to building sanitary sewer outlet and municipal sewer system, through installed sleeves.

E. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 23 16.13.

3.05 INSTALLATION - CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.
D. Mount lid and frame level in grout to elevation indicated.

3.06 FIELD QUALITY CONTROL
   A. Perform field inspection and testing in accordance with Section 01 40 00.
   B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
   C. Pressure Test: Test in accordance with Greenbook, Section 306-1.4.5.

3.07 PROTECTION
   A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 31 11
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Storm drainage piping, fittings, and accessories.
B. Connection of drainage system to private storm drainage systems.
C. Catch basins, Plant area drains, and Paved area drainage.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.
B. Section 31 23 16 - Excavation: Excavating of trenches.
D. Section 31 23 23 - Fill: Bedding and backfilling.
E. Section 33 05 13 - Manholes and Structures.

1.03 DEFINITIONS
A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04 REFERENCE STANDARDS

1.05 SUBMITTALS
A. See Section 01 3300 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating pipe, pipe accessories, and other drain components as indicated.
C. Manufacturer’s Installation Instructions: Indicate special procedures required to install Products specified.
D. Project Record Documents:
1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for materials and installation of the Work of this section.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. PVC Pipe, bell and spigot style solvent sealed joint end,
   3” to 15”: ASTM D3034, SDR 35
   18” to 48”: ASTM F679, SDR 35

2.02 PIPE ACCESSORIES

A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
C. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Storm Sewer Service " in large letters.

2.03 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 31 23 16.13.
B. Cover: As specified in Section 31 23 16.13.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to beginning work, verify that building service connection and municipal and site utility water main size, location, and invert are as indicated.

3.02 TRENCHING

A. See Section 31 23 16.13 - Trenching for additional requirements.
B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.03 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
C. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.
D. Install continuous trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 23 16.13.

3.04 INSTALLATION - CATCH BASINS, TRENCH DRAINS AND CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.
B. Form and place cast-in-place concrete base pad, with provision for storm drainage pipe end sections.

C. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.

D. Establish elevations and pipe inverts for inlets and outlets as indicated.

E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

F. Prefabricated trench drains:
   1. Excavate; prepare substrate and supports according to the manufacturer's printed installation instructions.
   2. Install prefabricated trench drain system according to the manufacturer's printed installation instructions.
   3. Expansion, Construction, and Control Joints: Do not locate trench drain system on an expansion, construction or control joint in concrete or pavement. Where concrete or pavement joints running transverse to direction of flow cross the trench drain system, locate concrete or pavement joints and trench drain system joints so that both coincide.
   4. Concrete Trench Support: 3000 pounds per square inch (20.68 MPa) compressive strength, minimum.
      a. Provide support on all sides of trench in minimum thickness recommended by trench drain system manufacturer.
      b. Screed and finish top edge of concrete flush with top surface of trench drain system.
      c. Do not use secondary edge finishing tools.

3.05 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section 01 40 00 - Quality Requirements.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
   1. Pressure Test: Test in accordance with Greenbook, Section 306-1.4.5.
   2. Infiltration Test: Test in accordance with Greenbook, Section 306-1.4.3.

3.06 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 41 11
SECTION 33 46 00

SUBDRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Filter aggregate and fabric and bedding.

1.02 RELATED REQUIREMENTS
   A. Section 31 23 16 - Excavation: Excavating for subdrainage system piping and surrounding filter aggregate.
   B. Section 31 23 16.13 - Trenching: Excavating and backfilling for site subdrainage systems.
   C. Section 31 23 23 - Fill: Backfilling over filter aggregate, up to subgrade elevation.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 3300 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on pipe drainage products, pipe accessories, and cleanouts.

1.05 REGULATORY REQUIREMENTS
   A. Conform to applicable code for materials and installation of the work of this section.

PART 2 PRODUCTS

2.01 PIPE MATERIALS
   A. Plastic Pipe: ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner meeting the requirements of AASHTO M 252, Type S, for diameters between 3 inches and 10 inches and AASHTO M 294, Type S, for diameters between 12 inches and 60 inches, soil-tight, bell and spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C.

   B. Use perforated pipe at subdrainage system only; unperforated beyond.

2.02 AGGREGATE AND BEDDING
   A. Filter Aggregate and Bedding Material: Granular fill as specified in Section 31 23 23.

   B. Filter Sand and Bedding Material: Sand as specified in Section 31 23 23.

2.03 ACCESSORIES
   A. Pipe Couplings: Solid plastic.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on the plans.

3.02 PREPARATION
   A. Hand trim excavations to required elevations. Correct over-excavation with general fill as specified in Section 31 23 23.
   B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction.

3.03 INSTALLATION
   A. Install and join pipe and pipe fittings in accordance with pipe manufacturer’s instructions.
   B. Lay pipe to slope gradients noted on Drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
   C. Place pipe with perforations facing down. Mechanically join pipe ends.
   D. Install pipe couplings.
   E. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.
   F. Place aggregate in maximum 4 inch (100 mm) lifts, consolidating each lift.
   G. Refer to Section 31 23 23 for compaction requirements. Do not displace or damage pipe when compacting.
   H. Beyond biofiltration zone, connect to storm drainage system with unperforated pipe.

3.04 FIELD QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Field inspection and testing.
   B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.05 PROTECTION
   A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION 33 46 00