BID DOCUMENTS COVER SHEET

CONTRACT DOCUMENTS
FOR
CONTRA COSTA COLLEGE

C-608 PE & Kinesiology
Complex Renovation

AT
2600 Mission Bell Drive
San Pablo, California, 94806

CONTRA COSTA COMMUNITY COLLEGE DISTRICT

Consist of the following:

DSA File #7-C1
DSA Application # 01-117456

Architect: LIONAKIS
1919 19th Street
Sacramento, CA 95811

Volume 02 - Divisions 21-33

December 5, 2018
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FIRE SUPPRESSION
SECTION 21 01 10

OPERATION AND MAINTENANCE OF WATER BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All Division 21 Sections.

1.2 SUBMITTALS

A. General:
   1. Refer to Section 01 00 00.
   2. Substitutions and changes from the approved drawings will be a deferred approval item. Such items must be signed by the Architect and approved by DSA prior to fabrication or installation.

B. Preparations.
   1. Prior to data collection and compilation, prepare and submit in duplicate an outline of the proposed organization and content.
   2. Compilation: Prepare and collect data concurrently with construction progress. Compile per submitted outline.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE MANUALS

A. Form of Submittals
   1. Prepare data in form of an instructional manual for use by Owner’s personnel.
      a. Cover: Identify each volume with typed or printed title, "OPERATING AND MAINTENANCE INSTRUCTION". List:
      b. Title of Project.
      c. Provide indexed tabs.
      d. Identify of separate structure as applicable.
      e. Identity of general subject matter covered in the manual.
   2. Format:
      a. Size: 8-1/2" x 11".
      b. Paper: 20 pound minimum, white, for typed pages.
      c. Text: Manufacturer’s printed data, or neatly typewritten.
      d. Drawings:
1) Provide reinforced punched binder tab, bind in with text.
2) Fold larger drawings to size of text pages.
e. Provide fly-leaf for each separate product, or each piece of operating equipment.
   1) Provide typed description of product and major component parts of equipment.
   2) Provide indexed tabs.

3. Binders:
b. Maximum ring size: 1”.
c. When multiple binders are used, correlate the data into related consistent groupings.

PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE DATA

A. General: Record data and operation and maintenance data are complimentary. Submittal items which may be required under both categories may be included only under one submittal if a statement to that effect is included in the other submittal.

B. Quality Assurance
   1. Preparation of data shall be performed by personnel.
      a. Trained and experienced in maintenance and operation of described products.
      b. Familiar with requirements of this Section.
      c. Skilled as technical writer to the extent required to communicate essential data.
      d. Skilled as draftsman competent to prepare required drawings.

C. Content of Manual
   1. Neatly typewritten table of contents for each volume, arranged in systematic order.
      a. A list of each product required to be included, indexed to content of the volume.
      b. List, with each product, name, address and telephone number of:
         1) Subcontractor or installer.
         2) Maintenance contractor, as appropriate.
3) Identify area of responsibility of each.
4) Local source of supply for parts and replacement.

c. Identify each product by product name and other identifying symbols as set forth in Contract Documents.

2. Product Data:
   a. Include only those sheets which are pertinent to the specific product.
   b. Annotate each sheet to:
      1) Clearly identify specific product or part installed.
      2) Clearly identify data applicable to installation.
      3) Delete references to inapplicable information.

3. Drawings:
   a. Supplement product data with drawings as necessary to clearly illustrate.
      1) Relations of component parts of equipment and systems.
      2) Control and flow diagrams.
   b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation
   c. Do not use Project Record Documents as maintenance drawings.

4. Written text, as required to supplement product data for the particular installation.
   a. Organize in consistent format under separate headings for different procedures.
   b. Provide logical sequence of instructions for each procedure.

   a. Provide a factory start-up report for each piece of equipment. Contractor start-up reports, unless contractor is a factory authorized representative will not be allowed.

6. Copy of each warranty, bond and service contract issued.
   a. Provide information sheet for Owner’s personnel, give:
      1) Proper procedures in event of failure.
      2) Instances which might affect validity of warranties or bonds.

D. Manual for Equipment and Systems:
   1. Submit three copies of complete manual in final form.
   2. Content, for each unit of equipment and system, as appropriate.
a. Description of unit and component parts.
   1) Function normal operating characteristics, and limiting conditions
   2) Performance curves, engineering data and tests.
   3) Complete nomenclature and commercial number of replaceable parts.

b. Operating procedures:
   1) Start-up, break-in, routing and normal operating instructions.
   2) Regulation, control, stopping, shut-down and emergency instructions.
   3) Summer and winter operating instructions.
   4) Special operating instructions.

c. Maintenance Procedures:
   1) Routing operations.
   2) Guide to “trouble-shooting”
   3) Disassembly, repair and reassemble.
   4) Alignment, adjusting and checking.

d. Servicing and lubrication schedule.
   1) List lubricants required.

e. Manufacturer’s printed operating and maintenance instructions.

f. Description of sequence of operation by control manufacturer.

g. Original manufacture’s parts list, illustrations, assembly drawings and diagrams required for maintenance.
   1) Predicted life of parts subject to wear.
   2) Items recommended to be stocked as spare parts.

h. As-installed control diagrams by controls manufacturer.

i. Each contractor’s coordination drawings:
   1) As-installed color-coded piping diagrams.

j. Charts of valve tag numbers, with location and function of each valve.

k. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.

l. Other data as required under pertinent sections of specifications.

3. Content for each electric and electronic system, as appropriate.

   a. Description of system and component parts.
1) Function, normal operating characteristics, and limiting conditions.
2) Performance curves, engineering data and tests.
3) Complete nomenclature and commercial number of replaceable parts.

b. Circuit directories of panel boards.
   1) Electric service.
   2) Controls.
   3) Communications

c. As-installed color-coded wiring diagrams.

d. Operating procedures.
   1) Routing and normal operating instructions.
   2) Sequences required.
   3) Special operating instructions.

e. Maintenance procedures.
   1) Routine operations.
   2) Guide to "trouble shooting".
   3) Disassembly, repair and reassembly.
   4) Adjustment and checking.

f. Manufacturer’s printed operating and maintenance instructions.

g. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.

h. Other data as required under pertinent sections of specifications.

i. Additional requirements for operating and maintenance data: Respective sections of Specifications.

E. Submittal Schedule

1. Submit two copies of preliminary draft of proposed formats and outlines of contents prior to start of work.
   a. Architect will review draft and return one copy with comments.

2. Submit one copy of complete data in final form fifteen days prior to final inspection or acceptance.
   a. Copy will be returned after final inspection or acceptance, with comments.

3. Submit specified number of copies of approved data in final form 10 days after final inspection or acceptance.
F. Instruction of Owner’s Personnel.

1. Prior to final inspection or acceptance, fully instruct Owner’s designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems

2. Operating and maintenance manual shall constitute the basis of instruction.
   a. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

END OF SECTION
SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. All Division 21 Sections.

1.2 SUMMARY
   A. Furnish and install all mechanical work shown on the drawings, specified herein, and as required for a complete and functional installation.

   B. This section includes materials and methods applicable to the work described in all Division 21 Sections. Specific work requirements of individual Mechanical Sections take precedence if in conflict with requirements of this Section.

   C. All chemicals utilized on site as part of coating, sealant, and other products shall not contain any chemical that is listed as part of Proposition 65 known carcinogens that are identified by NTP, IARC, and the USEPA California Proposition 65.

1.3 RELATED SECTIONS
   A. Division 3 - Concrete Work
   B. Division 26 - Electrical Work

1.4 DRAWINGS AND SPECIFICATIONS
   A. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, the Contractor shall make use of all data in all the contract documents and shall verify this information at building site.

   B. Information presented on Drawings and in the Specifications is based upon latest data available during their preparation. The Drawings and Specifications are for the assistance and guidance of the Contractor and exact locations, distances, levels, etc. will be governed by the structures and the site the contractor shall accept same with this understanding.

   C. The drawings indicate required size and points of termination of pipes, and suggest proper routes to conform to the structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of the Contractor to make the installation in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep openings and passageways clear.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall be responsible for delivery, storage, protection and placing of all equipment and materials.

B. Equipment stored and installed at the job site shall be protected from dust, water or other damage. Cover all equipment stored exposed to weather.

1.6 STRUCTURAL REQUIREMENTS

A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer.

1.7 CODES AND SAFETY ORDERS

A. All work and materials shall be in full accordance with the latest rules and regulations of the State Fire Marshall; the Safety Orders of the Division of Industrial Safety; the I.S.O. codes; the 2016 California Plumbing Code, 2016 Title 24, Part 5; the 2016 California Mechanical Code, Title 24, Part 4; the 2016 California Building Code, Title 24, Part 2, 2016 NFPA Codes, and other applicable laws and regulations. Nothing in the Drawings or Specifications shall be construed to permit work not conforming to these codes. Drawings and Specifications take precedence when work and materials called for exceed Code requirements.

1.8 INSTALLATION

A. Manufacturer's Instructions:

1. When specifications require that installation comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation.

2. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by specifications.

3. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.

4. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with the Engineer for further instructions.

5. Do not proceed with work without clear understanding.

1.9 PERMITS AND FEES

A. Obtain all permits and pay all required fees for permits and/or utility services. Inspections required during the course of construction shall be arranged as required. On completion of the work furnish the owners representative with certificates of inspection.
1.10 SITE CONDITIONS

A. Assume all responsibility for damage to adjoining properties; and restore property to its original condition, should damage occur as a result of the work of this section. Contractor shall thoroughly familiarize themselves with all site conditions. Should utilities not shown on the drawings be found during excavations, promptly notify the Architect for instructions as to further action. Failure to do so will make the Contractor liable for any and all damage thereto arising from his operations subsequent to discovery of such utilities not shown on plans.

1.11 SUBMITTALS

A. General

1. A submittal schedule shall be issued by the contractor within 15 days of award of the contract. This schedule shall allow for timely review and approval as required by the contract documents.

2. These requirements apply only to substitutions, submittals, and shop drawings.

3. The contractor shall review all submittals prior to submission to the Architect. Submittals not reviewed by the contractor will be returned to the contractor and will not be reviewed.

4. Any deviations from specified requirements shall be clearly indicated in submittals.

5. Any errors in or omissions from submittals and any consequences of these are the responsibility of the Contractor.

6. Partial or incomplete submittals may be rejected as not complying with requirements; the Contractor shall be liable for any resultant consequences.

7. Delayed submittals may be rejected as not complying with requirements. Whether accepted or rejected, delayed submittals will not be considered justification for extension of contract time or similar relief.

8. Submittals not required or permitted by the Specifications but made at the option of the Contractor, will be returned without review unless accompanied with written valid justification.

9. Submittal items improperly included with those of another category (such as a proposed substitution included with shop drawing submittal) are not valid and will be returned without review.

10. Within 35 calendar days after award of the contract, and before fabrications and installation of any material or ordering of any materials, submit for approval one copy in PDF format of complete submittal data on specified and proposed substituted equipment and materials. Submittals shall list all materials proposed identified with drawing symbols and specific data on equipment such as arrangements, performance curves, sizes, capacity, motor locations, and other pertinent data. Check all submittals for conformance to the requirements of the Construction Documents before forwarding to the architect for each item. No consideration will be given to substitutions submitted past 35 day limit. The contractor shall be responsible for all quantities and errors and omissions of submittals. Furnish samples when requested.
11. Equipment and materials specified as part of the specifications and drawings are listed by two manufacturer’s names. The first named manufacturer is the basis of design. The second named manufacturer has been determined to be an equivalent in quality or utility. The second named has not been specifically determined to conform to the first named in size, layout, electrical power, voltage, or impacts to building structure. The contractor is bound by all requirements for substitutes, as described below, for all second named manufacturers and equivalent equipment or products.

12. Each reviewed submittal will be marked to indicate review and directions as stated below.

13. Acceptance of a submittal does not relieve the Contractor of responsibility for omissions from the submittal or errors in the submittal.

B. Requirements

1. Refer to Division 1, Special Conditions.

2. Submit on all items specified herein:
   a. Shop Drawings as specified by NFPA 13
   b. Material catalog data
   c. Calculations
   d. Welder Certificate for pipe welding
   e. The certificate of flushing and test results (on the National Automatic Sprinkler and Fire Contractors Association [NAS & FCA] form)

C. Review

1. Submittals will be reviewed for general acceptability, not necessarily including all details. The engineers review is for general conformance with the design concept of the project and the information given in the contract documents. The contractor is solely responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating the work with that of other trades and performing all work in a safe and satisfactory manner. Corrections of comments made on this submittal during this review do not relieve contractor from compliance with the requirements of the contract documents or with its responsibilities listed herein.
   a. Proposed substitutes will be judged not only for the acceptability of the items themselves, but also how they will be used under the conditions of the particular project.
   b. Proposed substitutions will be judged also for compliance with qualifications and conditions stipulated in paragraph 1.13.

2. Each reviewed submittal will be marked to indicate review and directions as stated below.
   a. Acceptance of a substitute does not waive the specified requirements.
   b. Once a substitution is accepted, no revision or resubmittal may be made except for pressing and valid reason and after receipts of approval to do so.
D. Review Directions

1. The notation "No Exceptions Taken" indicates that no further submittal on the particular matter is required and that the Contractor may proceed with normally ensuing action. The notation may be applied to submittals on substitutions, shop drawings, record data, or operation and maintenance data. The submittal has only been reviewed for general conformance with the design concept of the Contract Documents. The contractor is responsible for the dimensions to be confirmed and correlated at the job site; information that pertains solely to the fabrication process or to the means and methods of construction; coordination of the work of all trades; and performing all work in a safe and satisfactory manner. This notation does not modify the contractor's duty to comply with the contract documents.

2. The notation "Make Corrections Noted" indicates that no further submittal on the particular matter is required, but the Contractor shall make all changes or corrections noted (but no others) before proceeding with normally ensuing action. The notation may be applied to submittals on substitutions or shop drawings (but usually not record data or operation and maintenance data).

3. The notation "Amend and Resubmit" indicates that the submittal is not accepted and must be revised, resubmitted, and reviewed again. In the case of submittal on substitutions and shop drawings so noted, the Contractor shall not proceed with any normally ensuing action until the resubmittal is reviewed. The notation may be applied to submittals on substitutions, shop drawings, record data, or operation and maintenance data.

4. The notation "Rejected - See Remarks" indicates that the submittal is not accepted and that resubmittal on the same subject matter is not allowed and will not be considered. The notation will be applied normally only to submittals on substitutions (usually not on shop drawings, record data, or operation and maintenance data).

5. The notation "Returned Without Review" indicates that the submittal or item has not been considered officially because it is either not proper, valid, required, or permitted by the Specifications and has no status or effect.

1.12 SHOP DRAWINGS

A. Prepare and furnish complete detailed plans for the installation of an automatic fire sprinkler system which will provide for maximum rate reduction in fire insurance premiums per requirements of, CBC, the State Fire Marshall, and conform to the supply main and riser locations as shown on the drawings.

B. These are working drawings of the building piping, as required by NFPA 13 and 24.

C. Include copies of the hydraulic calculations with each submittal prescribed above.

D. Submit six (6) sets of the above, bearing the "accepted" stamp of, the local fire department for review and approval. Submit one set of final corrected record drawings. After review, make all corrections required and make final submittal of three (3) reproducible transparencies and 6 blue line sets to the Architect.
E. The drawings submitted by the sprinkler contractor must show sufficient detail and dimensions to clearly indicate that sprinkler lines will be concealed or arranged neatly in exposed areas and will not conflict with structural, mechanical or electrical provisions as shown on the plans. Show feed main hanger locations.

F. Closely coordinate the schedule of this work with the work schedules or all other contractors.

G. The contractor is responsible for providing all shop drawings as described below so that the design professional has the opportunity to determine if the contractor understands the contract documents. It is not the purpose of shop drawings to assure that the contractor is meeting the requirements of the contract documents. Review and approval of a submittal neither extends nor alters any contractual obligation.

H. Accompany all substituted equipment with shop drawings showing revised ductwork and/or piping layouts in order to ascertain that substituted equipment does not adversely affect layout or work of others. Shop Drawings: The following conditions apply to shop drawings:
   1. Shop drawings are not and do not become Contract Documents.
   2. Processed shop drawing submittals and any instructions or requirements noted thereon are a part of the work, but they may not be used as a means of increasing the scope of the work.
   3. If deviations, discrepancies, or conflicts between shop drawing submittals and the Contract Documents are discovered either prior to or after the submittals are processed, the Contract Document requirements shall govern.

1.13 SUBSTITUTIONS

A. Whenever any equipment, material, or process is indicated or specified by patent of proprietary name and/or name of Manufacturer, in the Specifications and/or on the Drawings, it is understood that such specification is used to facilitate the description of the material and/or process and deemed to be followed by the words "or equal" unless noted "no substitute".

B. Substitute equipment and materials shall be equal in all respects including quality, arrangement, utility, physical size, capacity, and performance to those specified. Approval of substitute material will not relieve the contractor from complying with the requirement of the Drawings and Specifications. The contractor shall be responsible and at his own expense, for any changes caused by proposed substitutions which affect other parts of his own work or the work of other contractors.

C. The submittal of a proposed substitution shall clearly establish the following:
   1. The item can be transported into and installed in the intended space and in the manner shown.
   2. Required connections (electrical, piping, and other) can be properly made and adjoining work can be properly accomplished.
   3. The proposed substitute is similar to and of substance equal to that specified, is suited to the same use as that specified, and will perform the functions required by the design.
4. Motors for proposed substitute equipment will have the same minimum differential between motor brake horsepower and motor nameplate horsepower as the specified equipment.

5. All performance requirements shall be at least equal to the specified product or equipment including noise levels, cooling capacity, heating capacity, air flow quantity, etc.

D. By submitting a proposed substitution, the Contractor agrees to the following:

1. He will assume full responsibility for any and all modifications and necessary alterations arising from the use of the substitute item or material including all cost incurred by all other trades.

2. He will assume full responsibility for any delay in the construction schedule resulting from the use of the substitution.

3. He will prove harmless and indemnify the Owner and the Owner's design consultants from real or alleged damages that may result from the installation, use, or performance of a substitute material or product.

E. The following conditions apply to substitutions:

1. Submittals of substitutions are not and do not become part of the Contract Documents.

2. Contractor shall not order, fabricate, use, or install any substitute product or procedure unless he has received acceptance of the substitute from the Engineer.

3. Should the Contractor install any substitute product in violation of the above he shall remove it and install the specified product at his own expense.

4. The Contractor shall provide a letter stating that all the above items shall apply to all substituted products and equipment.

5. Any submittal for substituted equipment or product that does not clearly show that the substituted item is equal shall be marked rejected and no further submittal shall be allowed on the substituted item. Provide in submittal format documentation that the proposed item is exactly as specified in the contract documents.

1.14 GUARANTEE

A. Guarantee all work for one year from date of acceptance, against all defects in material, equipment and workmanship including repair of damage to any part of the premises resulting from leaks or other defects in material, equipment and workmanship. Guarantee shall be on form supplied by the owner's representative.

1.15 RECORD DRAWINGS

A. Indicate on reproducible drawings the actual location of all ductwork, piping and equipment as the work progresses. Dimension locations of underground service mains and branches. Deliver the drawings to the architect at the completion of the job.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Shop drawings:
   1. Make all drawings to an appropriate scale, large enough to show all pertinent aspects of the item and the method of its connection into the work.
   2. Make each drawing sheet in a reproducible form such as a tracing, sepia, or Mylar transparency.

B. Grouping: Combine submittals in logical groupings; for example, submit Shop Drawings grouped by Sections of the Specifications, arranged in the specified sequence.

C. Shop Drawings: Four blue or black line prints of each for the Engineer.

D. Content:
   1. Shop drawings may be:
      a. Drawings or diagrams prepared by the Contractor, a supplier, a manufacturer, or other.
      b. Typewritten data or descriptions.
      c. Manufacturer’s printed brochures, descriptions, charts, instructions, or data sheets.

E. Timing: Submit all shop drawings prior to installation of any items included in submittal.

2.2 CORROSION PROOFING

A. Corrosion Proofing / U.V. Protection: Products which will be installed outdoors, exposed to the weather, exposed to moisture, or other potentially damaging conditions shall be constructed to resist the effects of such exposure.

B. Exterior casings shall have lapped or gasketed joints effectively sealed to prevent intrusion of moisture or other injurious substances.

C. Casings, ducts, pipes, or product items shall be constructed of materials which are fully resistant to harmful substances they may normally contact, or (if ferrous) shall be galvanized after fabrication, or shall be fully protected from such substances by paint or other coating in appropriate thickness or number of coats.

D. All bolts, nuts, screws, and washers shall be galvanized unless specified to be plated or unprotected.

E. Any exposed plastic pipe must have a U.V. inhibitor.

2.3 MATERIAL AND EQUIPMENT

A. All material and equipment shall be new, of the type, capacity and quality specified and free from defects. All materials and equipment shall be of the same brand or manufacturer throughout for each class of material or equipment wherever possible.
2.4 ACCESS BOXES

A. For below grade valves and piping devices
   1. Christy Concrete Products Company, Brooks, with galvanized steel checker plate recessed traffic lid flush with rim of box. Lids for boxes located in areas subject to vehicular traffic shall be constructed to withstand H2O live loading as defined by the American Association of State Highway Officials (16,000 pound maximum individual wheel load). Service identification shall be conspicuously welded on lid before galvanizing. Provide manufacturer’s box extensions to bring box bottom three inches below bottom of valve and box top flush with finish grade.
   2. Box sizes (non traffic)

<table>
<thead>
<tr>
<th>Type</th>
<th>Valve Size</th>
<th>Box No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>2 1/2&quot; and smaller</td>
<td>B-9</td>
</tr>
<tr>
<td>Water</td>
<td>3&quot; and 4&quot;</td>
<td>B-16</td>
</tr>
</tbody>
</table>

2.5 ACCESS DOORS

A. Unless specified otherwise by the Architect, provide access doors of the following type:

B. Concealed hinges, prime coated with rust-inhibitive paint, style of door to suit wall, ceiling, floor or roof construction and fire rating.
   1. Milcor Type M
   2. Milcor Type UFR, fire resistive type Underwriters Laboratory Class B, 1-1/2 hour rating meets CBC, IBCO and BOCA codes for two hour rated walls self latching with key lock, Elmdor/Stonman Type FR or equal.

C. Minimum size; 18" by 18".

D. Wall and ceiling access doors: Furnish as required for access to ducts, damper operators, duct mounted access panels, etc.; coordinate size and location to obtain access.

E. See architectural drawings for further requirements.

2.6 MISCELLANEOUS EQUIPMENT AND MATERIALS

A. Furnish and install miscellaneous equipment and materials required for the systems described whether or not specifically shown or specified.

PART 3 - EXECUTION

3.1 ACCESSIBILITY

A. Do not install any equipment, valve, control, motor, filter, or any other device requiring
maintenance or service in an inaccessible location or position. Install access doors as specified herein to render all such equipment serviceable whether specifically shown on the plans or not. Maintain code clearance to all equipment. Coordinate location of doors with lights, etc., and locate symmetrically with same.

3.2 PREPARATION

A. Observations: Check all project drawings and specifications; report any discrepancies before proceeding with the work and in time to avoid unnecessary rework.

B. Investigation: Examine the areas, conditions, and status of other work contiguous or connecting to the work to be performed; ensure that the time of installation is coordinated with other work.

C. Interruptions of Service: Portions of this work may involve connection to existing work, facilities, or utilities ties and may require interrupting shutdowns of same. Carefully plan, coordinate and execute such work so that any interruptions will be kept to a minimum in time and occurrence. Submit request for shutdowns and make shutdowns only after receiving written approval from the Owner.

D. Other: Correct any unsatisfactory conditions that may impede proper execution of the work. Ensure that all arrangements, personnel, materials, and tools are appropriate and adequate before proceeding.

3.3 INSTALLATION

A. General:
1. Material and equipment incorporated in the work shall be used or applied only for the purpose intended or specified.
2. Install piping and ductwork and all equipment that requires access with minimum vertical and horizontal clearances required by OSHA for service.
3. All mechanical systems such as ductwork, pipes and all other equipment shall have 2 inches minimum clearance.
4. Do not proceed with work without clear understanding.

B. Manufacturer's Instructions:
1. When specifications require that installation comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation.
2. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by specifications.
3. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.
4. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with the Engineer for further instructions.
5. Do not proceed with work without clear understanding.
3.4 DEMOLITION

A. General
1. Procedures shall be determined by the contractor.
2. Demolition work shall not be commenced until all temporary work such as fences, barricades, and any required warning lights and apparatus are furnished and installed and as required by law, regulation, or ordinance, or elsewhere in this specification.
3. Demolition work shall proceed in such a manner as to minimize the spread of dust and flying particles and to provide safe working conditions for personnel.
4. Fires and explosives shall not be permitted.

B. Protection
1. Contractor shall conform to all Federal, State, and local ordinances related to the protection of the public and Contractor’s personnel and the flow of traffic. Provide protection for persons and property throughout the progress of the work.
2. Existing work damaged by the contractor in the execution of this Contract shall be restored to former condition by the contractor to the satisfaction of the Owner without an increase in the Contract Sum and without an extension of the Contract Time.

C. Disposition of Materials
1. All materials and equipment not scheduled to be salvaged, including debris and all rejected salvaged materials, shall become the property of the Contractor and shall be disposed of off-site in a legal manner. Location of dump and length of hall shall be the contractor’s responsibility.

3.5 LOCATION OF EQUIPMENT AND PIPING

A. Where job conditions do not permit the installation of piping, etc. in the location shown, it shall be brought to the engineer's attention immediately before fabrication of piping, etc. and the relocation required shall be determined in a joint conference.

B. The contractor will be held responsible for the relocating of any items installed without first obtaining the architect's or engineer's approval. Remove and relocate such items at the contractors expense as so directed by the architect or engineer.

C. Where piping is left exposed within a room, run in vertical or horizontal planes. Maintain uniform spacing between parallel lines and/or adjacent wall, floor or ceiling surfaces.

D. Horizontal runs of pipe suspended from ceilings shall provide for maximum clearance below.

E. Make minor changes in locations of equipment, piping, etc. from locations shown including minor offsets when directed by the engineer, at no additional cost to the owner.
3.6 CARE AND CLEANING

A. Clean and adjust all equipment at completion of installation to provide operating conditions satisfactory to the engineer. Remove broken, damaged or defective parts; repair or replace as directed by engineer. Remove surface material and debris resulting from this work when directed.

3.7 FLASHINGS

A. Furnish and install a waterproof flashing for each pipe, duct, or other penetration through roof or wall. Flashings shall be 4 lb. seamless flashings Semco 1100 series with counter flashing as detailed, except in metal roofs flashing for pipes through roof shall be furnished by the roofing contractor. Where details are not specifically delineated, submit details for review.

3.8 PAINTING

A. Painting is included under the Painting and Finishing Section. It shall be the responsibility of the Contractor to properly protect all equipment and controls during painting operations and the Contractor shall repair and/or replace any item damaged due to painting that was not properly protected.

3.9 ACCESS DOORS

A. Provide access doors to all concealed equipment, valves, controls, etc. Locate doors where shown or to be coordinated and symmetrically located with lights, diffusers, etc. Access doors furnished by the contractor shall be installed by the general contractor.

3.10 RECORD DATA

A. Compilation

1. Record and collect information concurrently with construction progress and date all entries; make drawing entries within 24 hours after occurrence of change or installation requiring recording. Any concealed work covered before recording data shall be uncovered as directed or as necessary to obtain data.
   a. Record information on drawing prints using an erasable colored pencil (not ink or indelible pencil); describe clearly by note or graphic line as appropriate.

2. Locate any concealed work adequately to allow future access with reasonable ease and accuracy.
   a. Identify the plan location of all stub outs, pipe lines, etc., which are buried or concealed in the structure, whether installed where shown on the contract drawings or in a different location; show actual field dimensions from column lines, wall lines, or other permanent reference lines or points.
   b. In many cases on the contract drawings, the arrangement of conduits, pipes, ducts, and similar items is shown schematically rather than as a precise scaled layout. Identify the actual location of these with horizontal and vertical dimensions. If such lines are exposed or readily accessible, omit dimensional identification.
c. When any work is installed of size, dimension, slope, or location different from that shown on the contract drawings, note the deviation on the Project Record set. If the variations are substantial or cannot be shown clearly on the record drawings, make a new drawing and attach to the Record set.

3. On other documents
   a. Where changes occur in specifications, clearly indicate same in ink, colored pencil, or rubber stamp.
   b. Where installed equipment differs from that specified (e.g., by accepted substitution or change order) note in the specifications and include complete data on same.

END OF SECTION
SECTION 21 05 13
COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All Division 21 Sections.

1.2 SUMMARY

A. Furnish and install all mechanical work shown on the drawings, specified herein, and as required for a complete and functional installation.

B. This section includes materials and methods applicable to the work described in all Division 15 Mechanical Sections. Specific work requirements of individual Mechanical Sections take precedence if in conflict with requirements of this Section.

1.3 RELATED SECTIONS

A. Division 3 - Concrete Work

B. Division 26 - Electrical Work

PART 2 - PRODUCTS

2.1 MOTORS AND STARTERS

A. Motors furnished as part of mechanical equipment shall be of size indicated and shall have starting torque sufficient to start and drive equipment load to which they are connected.

B. Electric motors shall be NEMA Premium efficiency, Gould "E 3Plus," or equal. Provide motors with maximum efficiency and power factor at their normal load operating point.

C. Motor enclosures shall be:
   1. Open drip proof for general use.
   2. Totally enclosed for wet or exterior use.
   3. Explosion-proof for hazardous location use.

D. Electric Motors of ¾ HP rating and over, heavy duty, ball bearing, open (drip-proof), squirrel cage induction type, normal starting torque 60 cycle service, 400 F continuous rating, and shall conform in all respects to the latest applicable standard of NEMA and AIEE. Motors up to ¾ HP rating shall have sleeve or ball bearing. Electric motors which are not housed within equipment they serve, shall be stamped for Quiet-Operation. Motors shall be of an Energy Efficient design meeting C.E.C., Title 24.

E. Motor starters and contactors except those in motor control centers shall be included in the mechanical work.
F. Starters: Starters furnished integral to, or specifically for, mechanical equipment shall be Square D, General Electric, Cutler-Hammer, or equal and shall comply with the following:

1. Enclosures shall be NEMA Standard to suit location/duty:
   a. Type 1: general purpose.
   b. Type 3: rain tight.
   c. Type 4: watertight.
   d. Type 7&9: explosion proof.

2. Thermal overload protection devices shall be provided as follows:
   a. One for single-phase motors.
   b. Three for three-phase motors.
   c. One for each ungrounded conductor for each winding of multi-wound or multi-speed motors.

3. Starters for motors up to 1/2 HP may be manual type if no interlocking is required; pilot light to indicate ON position is required.

4. Starters for motors up to 30 HP shall be magnetic across-the-line type except as stipulated above.

5. Starters for motors over 30 HP shall be transition-type magnetic-reduced voltage unless specified otherwise. Coordinate the characteristics to ensure adequate starting torque and to limit the starting current to a level compatible to the electrical system and acceptable to the utility company/agency.

6. Magnetic starters shall be provided with:
   a. 120-volt control circuits.
   b. H-O-A switch in cover.
   c. Auxiliary contacts for necessary interlocking.
   d. Integral disconnect switch or circuit breakers for branch circuit, short-circuit and ground-fault protection.

7. Short-circuit interrupting capacity of starters and disconnects shall be adequate for voltage employed and for current to be interrupted. This may require use of high interrupting capacity breakers or current limiting fuses. If fuses are used, provide three spares for each disconnect.

8. Starters shall be compatible with the motor they control.

PART 3 - EXECUTION

3.1 ELECTRICAL REQUIREMENTS

A. Provide working space around electrical equipment in compliance with the applicable Code and all Safety Orders.

B. Coordinate the Mechanical Work with the Electrical Work to comply with the above. Furnish and set in place all motors and duct or pipe installed controls.
C. Location of all new switches shall be verified with the architect or architect before roughing-in. Furnish necessary control diagrams and instruction for the proper installation of the controls.

D. Assume responsibility to insure that all motors are connected with flexible conduit per Division 26 requirements.

E. Assume responsibility for the proper supervision and testing of the controls for sequence of operation.

F. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers Association.

G. All equipment electrical characteristics shall be as noted on the drawings, or as specified. Verify before ordering any equipment.

H. Before permitting operation of any equipment which is furnished, installed or modified under this contract, review all wiring connections that pertain to mechanical equipment or work, and verify that these connections are correct.

I. Ascertain that the over-load protection devices installed are of the correct type, rating and setting to properly protect this equipment.

J. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize mechanical equipment wiring diagrams to coordinate with the electrical systems so that proper wiring of the equipment involved is affected.

END OF SECTION
SECTION 21 05 23

GENERAL DUTY VALVES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
   A. All Division 21 Sections.

1.02 SUMMARY
   A. Furnish and install all work shown on the drawings, specified herein, and as required
      for a complete and functional installation.
   B. This section includes materials and methods applicable to the work described in all
      Specification Sections. Specific work requirements of individual Specification Sections
      take precedence if in conflict with requirements of this Section.

1.03 RELATED SECTIONS
   A. Division 3: Concrete Work
   B. Division 26: Electrical Work
   C. PRODUCTS

1.04 GATE AND BUTTERFLY VALVES
   A. Gate valves shall be approved rising stem type (OS&Y).
   B. Butterfly valves shall be approved with weatherproof actuator.

1.05 VALVE BOXES
   A. Underground valve box shall be "Brooks or "Christy" marked for service.

PART 2 - EXECUTION

2.01 TAMPER RESISTANCE
   A. All exposed valves shall be chained to prevent accidental shutting of the valves.
   B. All shut off valves shall be equipped with tamper switches.

END OF SECTION
SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE SUPPRESSION AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All Division 21 Sections.

1.2 SUMMARY

A. Furnish and install all work shown on the drawings, specified herein, and as required for a complete and functional installation.

B. This section includes materials and methods applicable to the work described in all Division 21 Specification Sections. Specific work requirements of individual Division 21 Sections take precedence if in conflict with requirements of this Section.

1.3 SUBMITTALS

A. Submit proposed alternative methods of attachment for review and approval by the Engineer, prior to deviating from the requirements given below.

B. For all seismic bracing systems, submit structural calculations and details prepared and signed by the Contractors licensed engineer which include all resultant forces applied to the building structure. Do not overstress building structure. The maximum allowable loads are as indicated in 3.1 of this specification. The submittal data required does not require an analysis of the building structural numbers and their reaction to the loads of the piping. The submittal data needs to address attachment methods and shall include calculations indicating the forces that are applied to the building structure at the point of attachment. Calculations will be reviewed for compliance with design criteria, not for arithmetic.

1.4 RELATED SECTIONS

A. Division 3: Concrete Work

B. Division 26: Electrical Work

1.5 drawings and specifications

A. Information presented on Drawings and in the Specifications is based upon latest data available during their preparation. The Drawings and Specifications are for the assistance and guidance of the Contractor and exact locations, distances, levels, etc. will be governed by the structures and the site the contractor shall accept same with this understanding.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

A. B-Line, Superstrut, Tolco, Grinnell, or equal. Numbers are B-line.
B. Finish: Electro-Chromate or hot dipped galvanized.

C. Individual: B3690, B3100 cleaves or B3110 with H-104 all thread rod. Use B3110 for pipe subject to movement.

D. Trapeze Suspension, for three or more pipes B-Line 1-5/8" width channel or a size suitable for load in accordance with manufacturer's published load ratings. No deflection to exceed 1/180 of a span.

E. Trapeze Supporting Rods: Diameter sufficient to support the load with a safety factor of 5. Anchor rods securely to building structure. See part three for minimum sizes.


G. Size: For insulated pipe - B3690 pipe hangers sized to allow pipe insulation to pass continuously through the hanger.

H. Insulated Pipe Shields: Utilize isolated pipe supports at all insulated pipe hanger locations.

I. Isolators: 319CT or Trisolator isolators at all hangers and clamps supporting uninsulated piping and tubing and at all points that pipe comes in contact with structure or other pipes.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

A. General: Support all piping so that it is firmly held in place by approved iron hangers and supports and special hangers as required or as scheduled on the drawings.

1. Rigidly fasten hose faucets, and similar items at ends of pipe branches to the building construction near point of connection.

B. Hanger Installation: On all insulated pipes, install the hangers on the outside of the pipe covering and not in contact with the pipe. Burning, welding, cutting, or drilling on any structural member may only be done if approved by the structural engineer. No valve or piece of equipment shall be used to support the weight of any pipe. Provide a hanger close to the point of change of direction of pipe run in either horizontal or vertical plane. Place supports and hangers for cast iron soil pipe as close as possible to joints; when hangers or supports do not come within one foot of a branch line fitting, install an additional hanger or support at the fitting. Protect insulation, when pipe is insulated, at each hanger with 180 degree, 18 gauge, 12 inch long G.I. Saddles.
C. Hanger Spacing Schedule:

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>1&quot; dia to 1 1/4&quot;</th>
<th>1 1/2&quot; to 2&quot; dia</th>
<th>2 1/2&quot; dia &amp; over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Pipe</td>
<td>*12' - 0&quot;</td>
<td>15' - 0&quot;</td>
<td>15' - 0&quot;</td>
</tr>
</tbody>
</table>

D. Rod Size Schedule:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>½&quot; – 2&quot;</th>
<th>2 ½&quot; – 6&quot;</th>
<th>8&quot; &amp; Over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rod Size:</td>
<td>3/8&quot;</td>
<td>1/2&quot;</td>
<td>3/8&quot;</td>
</tr>
</tbody>
</table>

E. Anchor pipe subject to expansion or contraction in a manner permitting strains to be evenly distributed.

F. Methods of attachment and sizes shall conform to NFPA 13 and FM data sheet 2-8.

G. All hangers and fasteners are subject to the approval of the Structural Engineer.

H. Provide beam clamp retaining straps for all pipe supports attached to structural beams.

I. Support fire-protection system piping independent of other piping.

END OF SECTION
SECTION 21 05 48

VIBRATION AND SEISMIC CONTROLS FIRE SPRINKLER AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. All Division 21 Sections.

1.2 SUMMARY
   A. Furnish and install all work shown on the drawings, specified herein, and as required for complete and functional installation.
   
   B. This section includes materials and methods applicable to the work described in all Division 21 Specification Sections. Specific work requirements of individual Division 21 Sections take precedence if in conflict with requirements of this Section.

1.3 RELATED SECTIONS
   A. Division 3: Concrete Work.
   B. Division 16: Electrical Work.

1.4 SEISMIC RESISTANCE
   A. Furnish and install all systems, units, equipment, and parts to meet or exceed current applicable requirements for seismic resistance specified by codes, regulations, or agencies having jurisdiction. Include all supports, anchors, braces and other restraining devices required. All seismic restraints will meet the following site specific seismic design criteria:
      1. Seismic Design Category D, 2) Importance Factor, Ip = 1.0 except Ip = 1.5 for fire sprinkler piping and 1 and 3) SDS = 1.64
      2. Seismic restraints are the responsibility of the contractor.

PART 2 - PRODUCTS

2.1 Bracing SYSTEMS
   A. Provide approved types as manufactured by Grinnell, Hilti or Tolco.
PART 3 - EXECUTION

3.1 SWAY BRACING

A. Provide earthquake sway bracing in accordance with NFPA 13 and FM data sheet 2-8 on all feed and cross mains to meet current seismic requirements. Install exposed bracing in a neat workmanlike manner.
SECTION 21 07 00

FIRE SPRINKLER SYSTEMS INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All Division 21 Sections.

1.2 SECTION INCLUDES

A. This Section describes insulation materials, methods, and applications for work. Special or specific details, applications, features, or methods may be described in work descriptions Sections or on the drawings.

1.3 REFERENCES

A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:

B. American Society for Testing of Materials Specifications:
   2. ASTM C 585, "Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)"

1.4 SYSTEM PERFORMANCE


B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of applicable building codes when tested in composite form per one of the following nominally equivalent test methods:

C. American Society for Testing of Materials: ASTM E 84

D. Underwriters' Laboratories, Inc.: UL 723, CAN/ULC-S102-M88

E. National Fire Protection Association: NFPA 255

F. Molded pipe insulation shall be manufactured to meet ASTM C 585 for sizes required in the particular system.

G. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547.
1.5 QUALITY ASSURANCE

A. Qualifications of Installers: only a licensed firm employing installers specifically skilled and experienced in applying insulation to piping shall do Insulation work.

B. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in above.

C. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

D. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

1.6 CODES AND STANDARDS:

A. California Code of Regulations - Title 24.

1.7 DELIVERY AND STORAGE OF MATERIALS

A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way.

C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the contractor is able to demonstrate that wet insulation when fully dried out (either before installation or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance.

D. Batt acoustical insulation for interior wall construction.

E. Batt thermal insulation for exterior wall construction.

1.8 REFERENCES

A. ASTM C665 - Mineral Fiber Blanket Thermal Insulation

1.9 REGULATORY REQUIREMENTS

A. Comply with Title 24, Part 2, Chapter 7, fire resistivity ratings.
1.10 SUBMITTALS
   A. Product Data:
      1. Submit materials list in accordance with Section 01330.
      2. Prepare complete materials list identifying specific insulation types and applications.

1.11 PRODUCT HANDLING
   A. Protection:
   B. Deliver, store and handle all products in a manner to prevent damage and deterioration.
   C. Use all means necessary to protect the installed work and materials of all other trades.
   D. Deliver all materials in unopened bundles, labeled with date of manufacturer and testing agency approval.

PART 2 - PRODUCTS

2.1 FIRE SPRINKLER SYSTEMS EQUIPMENT INSULATION: SEE 21 07 16

2.2 FIRE SPRINKLER SYSTEMS PIPING INSULATION: SEE 21 07 19

PART 3 - EXECUTION

3.1 APPLICATION / INSTALLATION
   A. Use the types and thickness of insulation specified in work description Sections.
   B. Apply insulations in accordance with the manufacturer's recommendations and with instructions specified herein or noted on the drawings.
   C. Install insulations only after the systems, items, and equipment have been installed and tested, inspected, and accepted. Exceptions: Slip-on piping insulation and equipment insulations installed at the factory.
   D. Fit insulation snugly to the item being insulated; butt all joints tightly with no voids, spaces, or thin spots.
   E. Seal all joints completely; where sealing tape is used, center the tape over the joint.
   F. Except where specified or necessary, do not use staples or fasteners which penetrate vapor barrier jackets or covers on cold systems or equipment; where such penetrating fasteners are used, seal each penetration completely to maintain the vapor barrier integrity. All penetrations of the ASJ and exposed ends of insulation shall be sealed with vapor barrier mastic. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.
   G. Use adhesives, mastics, cements, sealants, and finishes undiluted unless specifically directed otherwise; apply per manufacturer's directions.
H. Install outdoor jacketing or other specified weather proofing or finishing on all insulations outdoors.

I. Install all indoor exposed insulation with extra care and finish neatly.

J. Follow specified methods of installation unless alternative methods are submitted and approved.

3.2 FINISHING

A. Finishes and Protection:
   1. Insure that the exterior finish of all insulation is applied and complete as specified
   2. Make ready for painting, or painted to match existing including color where specified for paint.
   3. Install all metal jackets or protective sheathing where specified.

B. Repair, Touchup: Properly repair and touchup all dents, rips, tears, or other damage inflicted on jackets or exterior surfaces of insulation. Breaks or punctures in the vapor barrier of external insulation will not be accepted and must be repaired prior to project acceptance.

END OF SECTION
SECTION 21 07 16

FIRE SPRINKLER SYSTEMS EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SEE 21 07 00 AND 21 07 19

PART 2 - PRODUCTS

2.1 SEE 21 07 19

PART 3 - EXECUTION

3.1 EQUIPMENT/TANKS
   A. Use System IP3 (Elastomeric Foam)
      1. 3/4” thickness for all sizes.
   B. Treat equipment face piping as follows:
      1. Where piping is subject to condensation and where installed above grade outdoors
         insulate piping completely to the point of equipment connection.
      2. Where not subject to condensation terminate insulation at the outlet side of the
         equipment shut-off valve, leaving the face piping un-insulated, 24” max, unless
         noted otherwise, except where exposed to outdoors.

END OF SECTION
SECTION 21 07 19

FIRE SPRINKLER SYSTEMS PIPING INSULATION

PART 1 - GENERAL

1.1 GENERAL

A. A continuous, intact vapor barrier is critical for all pipes conveying fluids at temperatures less than 75° F.

B. All insulation material shall have a mold, humidity, and erosion resistant face, that meets the requirements of 2016 CMC Standard No. 6-1.

C. Insulation applied to the exterior surface of pipes located in buildings shall have a flame spread of no more than 25 and a smoke developed rating of not more than 50.

D. All requirements of Section 21 07 00 apply to this section.

PART 2 - PRODUCTS

2.1 IP-3 ELASTOMERIC FOAM

A. Insulation shall be Elastomeric Foam Insulation. Insulation should have a maximum service temperature of 210° F, a minimum service temperature of -40° F, and a "K" factor of .28 at 75° F. The flame spread of the insulation shall be 25 or less, and smoke density shall be 50 or less when tested in accordance with ASTM E84.

B. Provide U.V. protective coating for all outdoor applications.

C. Rubatex R-180-FS/R-1800-FS, Armstrong Armaflex or equal.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Fire Sprinkler Piping: Insulate all piping exposed outside of exterior walls, on the roof and under canopies.
   1. Use System IP-3 (Elastomeric Foam).
      a. 3/4" thickness with U.V. protection for all sizes.

3.2 INSTALLATION

A. Unless specifically excluded herein or on the drawings, insulate all parts of the piping systems, including fittings, flanges, valves, and pipe-mounted devices, except do not cover nameplates on devices.

B. Install insulation in removable sections over unions, flanges, and line components or devices requiring periodic maintenance.

C. Install insulation butted tightly to transitions such as insulated pipe shields, insulated pipe sleeves, equipment connections, etc.
D. Install insulation on piping systems so that condensation will not occur. Insulate pipe supports where hanger is directly in contact with pipe up to the point of connection to the building structure. All piping shall be supported in such a manner that neither the insulation nor the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing shall be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier shall be continuous, including material covered by the hanger saddle.

E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.

F. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable sealant to maintain vapor barrier integrity.

END OF SECTION
SECTION 21 13 13

WET PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. All Division 21 Sections.

1.2 SUMMARY
   A. General: Furnish and install all engineering, design, materials, tools, equipment and perform all labor necessary for the complete installation of a fire sprinkler system and related items to provide complete functional systems in accordance with the requirements of 2016 NFPA 13 and the CBC, in all areas of the building.
   B. Each system to include, but not limited to:
      1. All pipe, fittings, sprinklers, hangers, valves, braces and all other accessories as necessary or required for a complete and operational system complying with all applicable codes.
      2. The contractor is responsible for securing approval from all agencies before submitting to the architect's office.
      3. Provide a fire sprinkler head at the top of each elevator shaft per NFPA. Provide fire-rated-, spring-loaded 2'x2' access panel within code-required maximum distance from sprinkler head.
      4. Contractor shall provide seismic isolation at all building seismic joints. See 21 05 48.

1.3 QUALITY ASSURANCE
   A. Standards: The system shall conform to the requirements of the National Fire Protection Association Standards for the Installation of Sprinkler Systems (NFPA 13, and 20). Provide coverage for various hazards in accordance with NFPA and local Fire Department requirements.
   B. The system may be a "scheduled" pipe sized system or "calculated" pipe sized system that satisfies the 2016 CBC, 2016 NFPA - 13 requirements. Details and computations for calculated systems must be submitted for approval. Pipe sizes shown outside buildings and for risers are minimum regardless of hydraulic calculations.
   C. Qualifications of Installers: A firm licensed to engineer and install fire protection systems such as that specified herein shall perform this work; the installing firm must also be regularly and currently engaged in the installation of such systems.
PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and equipment shall be new and of latest design of the manufacturer and shall be tested and approved by the Underwriters Laboratories, Inc. and Factory Mutual.

B. Sprinkler heads: Regular automatic closed type heads, glass bulb type of temperature rating (indicated below or required by NFPA). Standard concealed sprinkler heads shall be used at all finished ceiling and soffit locations. Heads in walls where freezing may occur (exposed to weather) shall be "dry pendant" sidewall type. Heads in areas without ceilings shall be standard pendant type. Fire sprinkler heads less than 2 ft, six inches from a supply register shall be intermediate temperature rated for 200 degrees. Escutcheons and canopies in lay-in ceilings shall be as selected by the architect.

C. Spare Sprinkler Heads: Furnish spare sprinkler heads placed in an emergency cabinet. For each cabinet provide one sprinkler wrench. The cabinet will be of No. 20 gauge pressure steel with red lacquer finish complete with manufacturer standard labeling. The spare heads shall be representative of, and in proportion to, the number of each type and temperature of heads installed. Locate cabinet where shown on plans or as directed by owner.

2.2 PIPE AND FITTINGS

A. Pipe fittings for installation below ground shall be cement lined, cast iron conforming to the requirements of American Water Works Association Standard Specification for cast iron special castings, Class D, 150 lb., AWWA C151 mechanical or push-on joint; with AWWA C104 cement-mortar lining, "Blue Brut" or PVC pressure pipe AWWA C900, UL approved for fire line service. If PVC permastran pipe is used with mechanical joint fittings, install according to manufacturer's requirements and recommendations.

B. Fire sprinkler piping, base of riser to 5'-0" outside building (Below ground):

C. Pipe: Acceptable piping materials are Class 50 cement-lined ductile iron with a working pressure of 250 psi per NFPA 24. All piping shall be listed for fire protection service.

D. Fittings: Fittings shall be rated to a minimum of 250 psi and meet applicable requirements of ANSI/AWWA and NFPA 24.

E. Materials shall comply with NFPA / ANSI & AWWA

F. The flange and spigot piece at the base of the riser shall be secured to the underground elbow at the base of the riser with four ¾" stainless steel tie rods for 8" risers, and two ¾" rods for 6" risers (for underground supply piping).

G. Pipe for installation above ground shall conform to ASTM A 795, A 53, or A135. Thin wall pipe with Victaulic couplings may be used for fire lines 2" and larger. Piping for line sizes 1½" and smaller shall be Schedule 40 pipe with screwed fittings. No thin wall pipe shall be used in conjunction with screwed fittings.

H. Gate valves shall be approved rising stem type (OS&Y).

I. Underground valve box shall be "Brooks or "Christy" marked for service.

J. All exposed valves shall be chained to prevent accidental shutting of the valves.
K. Sprinkler riser assemblies shall comply with all applicable codes. Furnish dry pipe valve and air compressor for all dry pipe systems. Provide insulation and heat tracing for riser freeze protection. All shut off valves shall be equipped with tamper switches.

L. Supports, Anchors, Bracing – See All Sections 21 05 29 and 21 05 48.

M. Piping Penetration Auxiliaries: Conform to NFPA 13 and the following:


O. Plates/Collars: 24-gauge galvanized sheet metal. Escutcheons: Polished chrome plated brass or painted metal.

2.3 FIRE ALARM

A. Alarm Bell: Furnish and install UL listed, exterior and interior Fire Alarm Bells in a location approved by the architect.

2.4 SYSTEM TYPE

A. The fire protection system for this building shall be “WET” system, in accordance with NFPA 13 requirements.

B. All heads exposed to freezing conditions shall be dry pendant type heads. All piping shall be run inside building lines on the warm side of the building insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install all work in accordance with requirements of NFPA 13 and the Fire Marshal. Notify the Fire Marshal in a timely manner when the installation progressed for required inspections.

2. Coordinate the installation of this work with adjacent or related work under other sections of the specifications. Any installed fire sprinkler work which interferes with other work or fails to meet the requirements of the Fire Marshal (as determined by progress or final observation) will be rejected and shall be removed, replaced, or revised to an acceptable condition at the contractor's expense.

3. Fire sprinkler, lines routed outside of the building insulation in soffits, overhangs, under canopies, or in ventilated un-insulated attics shall be protected by a “dry” compressed air charged or anti-freeze system.

4. Coordinate and install the work of this Section with related or adjacent work specified under other sections of the specifications.

5. System piping volume shall be capable of achieving water delivery to the inspector’s test pipe in less than sixty seconds, starting at the normal air pressure on the system and with any quick opening devices in operation.
6. Cutting, Notching and Patching
   a. Unless noted otherwise on Drawings, provide all cutting and notching required for work of this Section, including concrete saw cutting and core drilling; obtain Architect’s approval before cutting or core drilling. Coordinate with all reports provided by the Owner regarding any hazardous materials present prior to performing any work.

7. Provide all patching required for work of this Section, including concrete replacement; patch to match adjacent work and to architect’s satisfaction.

8. Any fire sprinkler pipe located outside of the buildings shall be protected with heat tape.

B. Above Grade Piping
   1. Use no coupling except where length of pipe between fittings exceeds 20 feet.
   2. Make reductions in pipe sizes with one piece reducing fitting. Bushings shall not be acceptable, except when standard fittings of proper size are not manufactured. Single bushings of the face type will be permitted up to 5% of total number of reducing fittings in the system. Where bushings are used, install with outer face flush with face of fitting opening being reduced.
   3. Install piping to clear lighting fixtures, air ducts, and other obstructions, minimum clearance 2 inches including concrete foundations, walls, and floors.
   4. All sprinkler piping shall be inspected prior to installation to ensure the pipe is free of welding slag and cutouts, and ensure that the welded fittings do not protrude into the path of water flow.
   5. Install piping level, plumb, and parallel to structure line except where shown otherwise or required by function or regulation to be angled or sloped.
   6. Install piping concealed within penetrations provided in the structure except where shown as exposed.
   7. Install piping without bending, springing, forcing, or placing undue stress on the pipe or fittings.
   8. Install piping to allow for expansion, contraction, and structural settlement.
   9. Install piping so it does not directly contact the structure except where shown or specified otherwise.
   10. Install piping so that it does not interfere with equipment access.
   11. The use of plain end pipe, fittings and coupling shall not be permitted, except for welded piping.
   12. Penetrations through fire rated walls shall be sealed in accordance with a recognized UL/FM assembly.

C. Below grade piping
   1. Piping installed under slab shall be cement lined cast iron, PVC or other plastic pressure piping shall not be allowed.
   2. Install per NFPA 24 and NFPA 13 and local jurisdiction.
3. The flange and spigot piece at the base of the risers shall be secured to the underground elbow at the base of the riser with four ¾” stainless steel tie rods for 8” risers, and two ¾” rods for 6” and smaller risers.

4. Install thrust blocks at all changes in direction sized in accordance with Factory Mutual Data Sheet 3-10.

5. Pipe supports – See Sections 21 05 29 and 21 05 48.

6. Provide 2” clear space around all pipe penetrations passing through concrete foundations, walls or floors.

D. Drains

1. Install auxiliary drains at all low points in the system. Install the inspector’s test drain at most remote high point in each system from the main riser. All inspectors’ test connections shall be installed in a readily accessible location. Use angle type drain valves. Five or fewer trapped heads may be drained through a plugged fitting. Pipe drain valves shall discharge as shown on the drawings, and as approved by the architect, outside building unless noted otherwise. Install in accordance with NFPA 13.

2. All piping in finished areas must be run concealed above ceilings, in walls or as shown and noted on the plans. Piping shall be run so as to occur on the warm side of all building insulation. The location of exposed piping, if permitted at all, shall be approved by the engineer and architect.

3.2 SPRINKLER HEAD LOCATIONS

A. Sprinkler heads shall be located in finished ceilings, soffits, overhangs, etc., in accordance with NFPA and CBC requirements but conforming to ceiling lighting, and building modules which may require additional heads for symmetry.

B. Sprinkler heads in the areas without ceilings shall be located on exposed piping run to conform to building lines and as approved by the Architect. The location of all piping, heads and equipment shall be submitted for final approval by the Architect who shall have final authority of location of same. The contractor shall allow for additional sprinkler heads which may be required for aesthetic purposes.

C. Heads in exterior walls and exterior soffits shall be located as shown on architectural exterior elevations or as approved by the architect.

3.3 COORDINATION

A. The sprinkler contractor shall be responsible to coordinate the location of sprinkler piping with all other trades such as ductwork, electrical work and plumbing work. The sprinkler contractor shall off-set and modify the sprinkler system as may be required to coordinate the sprinkler system with all other systems as shown and/or detailed. All sprinkler piping shall clear all other building services by at least 2 inches.

3.4 REPORTS

A. The system(s) must be inspected, tested, and approved and certified by the owner’s insurance carrier, DSA, and local fire department before acceptance of the project.
3.5 DETECTION, ALARM, AND ELECTRICAL WIRING
   A. Electrical contractor shall be responsible for all fire detection and alarm and wiring.
   B. Demonstrate proper operation of alarm systems.
   C. Electrical contractor shall provide all electrical wiring.

END OF SECTION
DIVISION 22
PLUMBING
SECTION 22 01 00
OPERATION AND MAINTENANCE OF PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. All levels of 22 00 00

   B. Preparations.
      1. Prior to data collection and compilation, prepare and submit in duplicate an outline of the
         proposed organization and content.
      2. Compilation: Prepare and collect data concurrently with construction progress. Compile
         per submitted outline.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE MANUALS

   A. Form of Submittals
      1. Prepare data in form of an instructional manual for use by Owner's personnel.
      2. Cover: Identify each volume with typed or printed title, "OPERATING AND
         MAINTENANCE INSTRUCTION". List:
            a. Title of Project.
            b. Provide indexed tabs.
            c. Identify of separate structure as applicable.
            d. Identity of general subject matter covered in the manual.
      3. Format:
         a. Size: 8-1/2" x 11".
         b. Paper: 20 pound minimum, white, for typed pages.
         c. Text: Manufacturer's printed data, or neatly typewritten.
         d. Drawings:
            1.) Provide reinforced punched binder tab, bind in with text.
            2.) Fold larger drawings to size of text pages.
         e. Provide fly-leaf for each separate product, or each piece of operating equipment.
            1.) Provide typed description of product and major component parts of equipment.
            2.) Provide indexed tabs.
      4. Binders:
         b. Maximum ring size: 1".
         c. When multiple binders are used, correlate the data into related consistent groupings.
PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE DATA

A. General: Record data and operation and maintenance data are complimentary. Submittal items which may be required under both categories may be included only under one submittal if a statement to that effect is included in the other submittal.

B. Quality Assurance

1. Preparation of data shall be done by personnel.
   a. Trained and experienced in maintenance and operation of described products.
   b. Familiar with requirements of this Section.
   c. Skilled as technical writer to the extent required to communicate essential data.
   d. Skilled as draftsman competent to prepare required drawings.

C. Content of Manual

1. Neatly typewritten table of contents for each volume, arranged in systematic order.
   a. A list of each product required to be included, indexed to content of the volume.
   b. List, with each product, name, address and telephone number of:
      1) Subcontractor or installer.
      2) Maintenance contractor, as appropriate.
      3) Identify area of responsibility of each.
      4) Local source of supply for parts and replacement.
   c. Identify each product by product name and other identifying symbols as set forth in Contract Documents.

2. Product Data:
   a. Include only those sheets which are pertinent to the specific product.
   b. Annotate each sheet to:
      1) Clearly identify specific product or part installed.
      2) Clearly identify data applicable to installation.
      3) Delete references to inapplicable information.

3. Drawings:
   a. Supplement product data with drawings as necessary to clearly illustrate.
      1) Relations of component parts of equipment and systems.
      2) Control and flow diagrams.
   b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
   c. Do not use Project Record Documents as maintenance drawings.

4. Written text, as required to supplement product data for the particular installation.
   a. Organize in consistent format under separate headings for different procedures.
   b. Provide logical sequence of instructions for each procedure.

a. Provide a factory start-up report for each piece of equipment. Contractor start-up reports, unless contractor is a factory authorized representative will not be allowed.

6. Copy of each warranty, bond and service contract issued.
   a. Provide information sheet for Owner’s personnel, give:
      1) Proper procedures in event of failure.
      2) Instances which might affect validity of warranties or bonds.

D. Manual for Equipment and Systems:
   1. Submit one copy of complete manual in final form in PDF format.
   2. Content, for each unit of equipment and system, as appropriate.
      a. Description of unit and component parts.
         1) Function normal operating characteristics, and limiting conditions
         2) Performance curves, engineering data and tests.
         3) Complete nomenclature and commercial number of replaceable parts.
      b. Operating procedures:
         1) Start-up, break-in, routing and normal operating instructions.
         2) Regulation, control, stopping, shut-down and emergency instructions.
         3) Summer and winter operating instructions.
         4) Special operating instructions.
      c. Maintenance Procedures:
         1) Routing operations.
         2) Guide to “trouble-shooting”
         3) Disassembly, repair and reassemble.
         4) Alignment, adjusting and checking.
      d. Servicing and lubrication schedule.
         1) List lubricants required.
      e. Manufacturer’s printed operating and maintenance instructions.
      f. Description of sequence of operation by control manufacturer.
      g. Original manufacture’s parts list, illustrations, assembly drawings and diagrams required for maintenance.
         1) Predicted life of parts subject to wear.
         2) Items recommended to be stocked as spare parts.
      h. As-installed control diagrams by controls manufacturer.
      i. Each contractor’s coordination drawings:
         1) As-installed color-coded piping diagrams.
      j. Charts of valve tag numbers, with location and function of each valve.
      k. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.
      l. Other data as required under pertinent sections of specifications.
3. Content for each electric and electronic system, as appropriate.
   a. Description of system and component parts.
      1) Function, normal operating characteristics, and limiting conditions.
      2) Performance curves, engineering data and tests.
      3) Complete nomenclature and commercial number of replaceable parts.
   b. Circuit directories of panel boards.
      1) Electric service.
      2) Controls.
      3) Communications
   c. As-installed color coded wiring diagrams.
   d. Operating procedures.
      1) Routing and normal operating instructions.
      2) Sequences required.
      3) Special operating instructions.
   e. Maintenance procedures.
      1) Routine operations.
      2) Guide to “trouble shooting”.
      3) Disassembly, repair and reassembly.
      4) Adjustment and checking.
   f. Manufacturer’s printed operating and maintenance instructions.
   g. List of original manufacturer’s spare parts, manufacturer’s current prices, and
      recommended quantities to be maintained in storage.
   h. Other data as required under pertinent sections of specifications.
   i. Additional requirements for operating and maintenance data: Respective sections of
      Specifications.

E. Submittal Schedule
1. Submit tow copies of preliminary draft of proposed formats and outlines of contents prior
   to start of work.
   a. Architect will review draft and return one copy with comments.
2. Submit one copy of complete data in final form fifteen days prior to final inspection or
   acceptance.
   a. Copy will be returned after final inspection or acceptance, with comments.
3. Submit specified number of copies of approved data in final form 10 days after final
   inspection or acceptance.

F. Instruction of Owner’s Personnel.
1. Prior to final inspection or acceptance, fully instruct Owner’s designated operating and
   maintenance personnel in operation, adjustment and maintenance of products, equipment and systems
2. Operating and maintenance manual shall constitute the basis of instruction.
a. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

END OF SECTION
SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section applies to all Division 22 Plumbing Sections.

1.2 SUMMARY

A. This section includes all plumbing (equipment, fixtures, pipe and fittings, specialties) inside the building(s) and outside the building(s) to the point of connection to site plumbing systems.

B. Provide complete plumbing systems including:
   1. Service connections to existing on-site utilities, and stubs for future connection to equipment provided under the work of this Section or other Sections of the Specifications.
   2. All piping systems for conduction of cold water, heated water, soil, waste, fuel gas, and other fluids or gases as shown or specified for plumbing work.
   3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings, piping, and other piping accessories as shown or specified for plumbing work.
   4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.
   5. All low voltage wiring for automatic fixtures as required.

C. All chemicals utilized on site as part of coating, sealant, and other products shall not contain any chemical that is listed as part of Proposition 65 known carcinogens that are identified by NTP, IARC, and the USEPA California Proposition 65 chemical repository contractors are not allowed to bring these chemicals on any California Intel site.

1.3 RELATED SECTIONS

A. Division 23 - HVAC

B. Division 26 - Electrical Work

C. Division 21 - Fire Sprinkler

1.4 DRAWINGS AND SPECIFICATIONS

A. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, the Contractor shall make use of all data in all the contract documents and shall verify this information at building site.

B. Information presented on Drawings and in the Specifications is based upon latest data available during their preparation. The Drawings and Specifications are for the assistance and guidance of the Contractor and exact locations, distances, levels, etc. will be governed by the structures and the site the contractor shall accept same with this understanding.
C. The drawings indicate required size and points of termination of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of the Contractor to make the installation in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep openings and passageways clear.

1.5 DELIVERY, STORAGE AND HANDLING

A. Contractor shall be responsible for delivery, storage, protection and placing of all equipment and materials.

B. Equipment stored and installed at the job site shall be protected from dust, water or other damage. Cover all equipment stored exposed to weather.

1.6 STRUCTURAL REQUIREMENTS

A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer.

1.7 CODES AND SAFETY ORDERS

A. All work and materials shall be in full accordance with the latest rules and regulations of the State Fire Marshall; the Safety Orders of the Division of Industrial Safety; the I.S.O. codes; latest edition of California Code of Regulations, 2016 Title 24, Part 6; the 2016 California Plumbing Code, Title 24, Part 5; the 2016 California Mechanical Code, Title 24, Part 4; the 2016 California Building Code, Title 24, Part 2, 2016 NFPA Codes, and other applicable laws and regulations. Nothing in the Drawings or Specifications shall be construed to permit work not conforming to these codes. Drawings and Specifications take precedence when work and materials called for exceed Code requirements.

1.8 INSTALLATION

A. Manufacturer's Instructions:
   1. When specifications require that installation comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation.
   2. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by specifications.
   3. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.
   4. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with the Engineer for further instructions.
   5. Do not proceed with work without clear understanding.

1.9 PERMITS AND FEES

A. Obtain all permits and pay all required fees for permits and/or utility services. Inspections required during the course of construction shall be arranged as required. On completion of the work furnish the owners representative with certificates of inspection.

B. Include in bid all costs for gas service including meter, regulators and service line installed by a gas utility company or a gas utility company approved contractor.
1.10 SITE CONDITIONS

A. Assume all responsibility for damage to adjoining properties; and restore property to its original condition, should damage occur as a result of the work of this section. Contractor shall thoroughly familiarize himself with all site conditions. Should utilities not shown on the drawings be found during excavations, promptly notify the Architect for instructions as to further action. Failure to do so will make the Contractor liable for any and all damage thereto arising from his operations subsequent to discovery of such utilities not shown on plans.

1.11 SUBMITTALS

A. General

1. A submittal schedule shall be issued by the contractor within 15 days of award of the contract. This schedule shall allow for timely review and approval as required by the contract documents.

2. These requirements apply only to substitutions, submittals, and shop drawings.

3. The contractor shall review all submittals prior to submission to the Architect. Submittals not reviewed by the contractor will be returned to the contractor and will not be reviewed.

4. Any deviations from specified requirements shall be clearly indicated in submittals.

5. Any errors in or omissions from submittals and any consequences of these are the responsibility of the Contractor.

6. Partial or incomplete submittals may be rejected as not complying with requirements; the Contractor shall be liable for any resultant consequences.

7. Delayed submittals may be rejected as not complying with requirements. Whether accepted or rejected, delayed submittals will not be considered justification for extension of contract time or similar relief.

8. Submittals not required or permitted by the Specifications but made at the option of the Contractor, will be returned without review unless accompanied with written valid justification.

9. Submittal items improperly included with those of another category (such as a proposed substitution included with shop drawing submittal) are not valid and will be returned without review.

10. Within 35 calendar days after award of the contract, and before fabrications and installation of any material or ordering of any materials, submit for approval one copy in PDF format of complete submittal data on specified and proposed substituted equipment and materials. Submittals shall list all materials proposed identified with drawing symbols and specific data on equipment such as arrangements, performance curves, sizes, capacity, motor locations, and other pertinent data. Check all submittals for conformance to the requirements of the Construction Documents before forwarding to the architect for each item. No consideration will be given to substitutions submitted past 35 day limit. The contractor shall be responsible for all quantities and errors and omissions of submittals. Furnish samples when requested.

11. Equipment and materials specified as part of the specifications and drawings are listed by two manufacturer’s names. The first named manufacturer is the basis of design. The second named manufacturer has been determined to be an equivalent in quality or utility. The second named has not been specifically determined to conform to the first named in size, layout, electrical power, voltage, or impacts to building structure. The
contractor is bound by all requirements for substitutes, as described below, for all second named manufacturers and equivalent equipment or products.

12. Each reviewed submittal will be marked to indicate review and directions as stated below.

13. Acceptance of a submittal does not relieve the Contractor of responsibility for omissions from the submittal or errors in the submittal.

B. Review

1. Submittals will be reviewed for general acceptability, not necessarily including all details. The engineers review is for general conformance with the design concept of the project and the information given in the contract documents. The contractor is solely responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating the work with that of other trades and performing all work in a safe and satisfactory manner. Corrections of comments made on this submittal during this review do not relieve contractor from compliance with the requirements of the contract documents or with its responsibilities listed herein.

   a. Proposed substitutes will be judged not only for the acceptability of the items themselves, but also how they will be used under the conditions of the particular project.

   b. Proposed substitutions will be judged also for compliance with qualifications and conditions stipulated in paragraph 1.13.

2. Each reviewed submittal will be marked to indicate review and directions as stated below.

   a. Acceptance of a substitute does not waive the specified requirements.

   b. Once a substitution is accepted, no revision or re-submittal may be made except for pressing and valid reason and after receipts of approval to do so.

C. Review Directions

1. The notation "No Exceptions Taken" indicates that no further submittal on the particular matter is required and that the Contractor may proceed with normally ensuing action. The notation may be applied to submittals on substitutions, shop drawings, record data, or operation and maintenance data. The submittal has only been reviewed for general conformance with the design concept of the Contract Documents. The contractor is responsible for the dimensions to be confirmed and correlated at the job site; information that pertains solely to the fabrication process or to the means and methods of construction; coordination of the work of all trades; and performing all work in a safe and satisfactory manner. This notation does not modify the contractor's duty to comply with the contract documents.

2. The notation "Make Corrections Noted" indicates that no further submittal on the particular matter is required, but the Contractor shall make all changes or corrections noted (but no others) before proceeding with normally ensuing action. The notation may be applied to submittals on substitutions or shop drawings (but usually not record data or operation and maintenance data).

3. The notation "Amend and Resubmit" indicates that the submittal is not accepted and must be revised, resubmitted, and reviewed again. In the case of submittal on substitutions and shop drawings so noted, the Contractor shall not proceed with any normally ensuing action until the resubmittal is reviewed. The notation may be applied
to submittals on substitutions, shop drawings, record data, or operation and maintenance data.

4. The notation "Rejected - See Remarks" indicates that the submittal is not accepted and that resubmittal on the same subject matter is not allowed and will not be considered. The notation will be applied normally only to submittals on substitutions (usually not on shop drawings, record data, or operation and maintenance data).

5. The notation "Returned Without Review" indicates that the submittal or item has not been considered officially because it is either not proper, valid, required, or permitted by the Specifications and has no status or effect.

1.12 SHOP DRAWINGS

A. The contractor is responsible for providing all shop drawings as described below so that the design professional has the opportunity to determine if the contractor understands the contract documents. It is not the purpose of shop drawings to assure that the contractor is meeting the requirements of the contract documents. Review and approval of a submittal neither extends nor alters any contractual obligation.

B. Accompany all substituted equipment with shop drawings showing revised ductwork and/or piping layouts in order to ascertain that substituted equipment does not adversely affect layout or work of others. Shop Drawings: The following conditions apply to shop drawings:

1. Shop drawings are not and do not become Contract Documents.

2. Processed shop drawing submittals and any instructions or requirements noted thereon are a part of the work, but they may not be used as a means of increasing the scope of the work.

3. If deviations, discrepancies, or conflicts between shop drawing submittals and the Contract Documents are discovered either prior to or after the submittals are processed, the Contract Document requirements shall govern.

1.13 SUBSTITUTIONS

A. Whenever any equipment, material, or process is indicated or specified by patent of proprietary name and/or name of Manufacturer, in the Specifications and/or on the Drawings, it is understood that such specification is used to facilitate the description of the material and/or process and deemed to be followed by the words "or equal" unless noted "no substitute".

B. Substitute equipment and materials shall be equal in all respects including quality, arrangement, utility, physical size, capacity, and performance to those specified. Approval of substitute material will not relieve the contractor from complying with the requirement of the Drawings and Specifications. The contractor shall be responsible and at his own expense, for any changes caused by proposed substitutions which affect other parts of his own work or the work of other contractors.

C. The submittal of a proposed substitution shall clearly establish the following:

1. The item can be transported into and installed in the intended space and in the manner shown.

2. Required connections (electrical, piping, and other) can be properly made and adjoining work can be properly accomplished.
3. The proposed substitute is similar to and of substance equal to that specified, is suited to the same use as that specified, and will perform the functions required by the design.

4. Motors for proposed substitute equipment will have the same minimum differential between motor brake horsepower and motor nameplate horsepower as the specified equipment.

5. All performance requirements shall be at least equal to the specified product or equipment including noise levels, cooling capacity, heating capacity, air flow quantity, etc.

D. By submitting a proposed substitution, the Contractor agrees to the following:

1. He will assume full responsibility for any and all modifications and necessary alterations arising from the use of the substitute item or material including all cost incurred by all other trades.

2. He will assume full responsibility for any delay in the construction schedule resulting from the use of the substitution.

3. He will prove harmless and indemnify the Owner and the Owner's design consultants from real or alleged damages that may result from the installation, use, or performance of a substitute material or product.

E. The following conditions apply to substitutions:

1. Submittals of substitutions are not and do not become part of the Contract Documents.

2. Contractor shall not order, fabricate, use, or install any substitute product or procedure unless he has received acceptance of the substitute from the Engineer.

3. Should the Contractor install any substitute product in violation of the above he shall remove it and install the specified product at his own expense.

4. The Contractor shall provide a letter stating that all the above items shall apply to all substituted products and equipment.

5. Any submittal for substituted equipment or product that does not clearly show that the substituted item is equal shall be marked rejected and no further submittal shall be allowed on the substituted item. Provide in submittal format documentation that the proposed item is exactly as specified in the contract documents.

1.14 GUARANTEE

A. Guarantee all work for one year from date of acceptance, against all defects in material, equipment and workmanship including repair of damage to any part of the premises resulting from leaks or other defects in material, equipment and workmanship. Guarantee shall be on form supplied by the owner's representative.

1.15 RECORD DRAWINGS

A. Indicate on reproducible drawings the actual location of all ductwork, piping and equipment as the work progresses. Dimension locations of underground service mains and branches. Deliver the drawings to the architect at the completion of the job.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Shop drawings:
   1. Make all drawings to an appropriate scale, large enough to show all pertinent aspects of the item and the method of its connection into the work.
   2. Make each drawing sheet in a reproducible form.

B. Grouping: Combine submittals in logical groupings; for example, submit Shop Drawings grouped by Sections of the Specifications, arranged in the specified sequence.

C. Shop Drawings: PDF files for the Engineer.

D. Content:
   1. Shop drawings may be:
      a. Drawings or diagrams prepared by the Contractor, a supplier, a manufacturer, or other.
      b. Typewritten data or descriptions.
      c. Manufacturer's printed brochures, descriptions, charts, instructions, or data sheets.

E. Timing: Submit all shop drawings prior to installation of any items included in submittal.

2.2 CORROSION PROOFING

A. Corrosion Proofing / U.V. Protection: Products which will be installed outdoors, exposed to the weather, exposed to moisture, or other potentially damaging conditions shall be constructed to resist the effects of such exposure.

B. Exterior casings shall have lapped or gasketed joints effectively sealed to prevent intrusion of moisture or other injurious substances.

C. Casings, ducts, pipes, or product items shall be constructed of materials which are fully resistant to harmful substances they may normally contact, or (if ferrous) shall be galvanized after fabrication, or shall be fully protected from such substances by paint or other coating in appropriate thickness or number of coats.

D. All bolts, nuts, screws, and washers shall be galvanized unless specified to be plated or unprotected.

E. Any exposed plastic pipe must have a U.V. inhibitor.

2.3 MATERIAL AND EQUIPMENT

A. All material and equipment shall be new, of the type, capacity and quality specified and free from defects. All materials and equipment shall be of the same brand or manufacturer throughout for each class of material or equipment wherever possible.

2.4 FILTERS

A. A complete set of filters shall be supplied for use during the construction period. A complete set of new filters shall be installed before testing and balancing.
2.5 ACCESS BOXES

A. For below grade valves and piping devices
   1. Christy Concrete Products Company, Brooks, with galvanized steel checker plate recessed traffic lid flush with rim of box. Lids for boxes located in areas subject to vehicular traffic shall be constructed to withstand H20 live loading as defined by the American Association of State Highway Officials (16,000 pound maximum individual wheel load). Service identification shall be conspicuously welded on lid before galvanizing. For gas service, drill twelve 3/8" diameter vent holes through lid before galvanizing. Provide manufacturer's box extensions to bring box bottom three inches below bottom of valve and box top flush with finish grade.

2. Box sizes (non traffic)

<table>
<thead>
<tr>
<th>Type</th>
<th>Valve Size</th>
<th>Box No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>2 1/2&quot; and smaller</td>
<td>B-9</td>
</tr>
<tr>
<td>Water</td>
<td>3&quot; and 4&quot;</td>
<td>B-16</td>
</tr>
<tr>
<td>Water</td>
<td>5&quot; and 6&quot;</td>
<td>B-30</td>
</tr>
<tr>
<td>Water</td>
<td>8&quot;</td>
<td>1</td>
</tr>
</tbody>
</table>

2.6 ACCESS DOORS

A. Unless specified otherwise by the Architect, provide access doors of the following type:
   1. Concealed hinges, prime coated with rust-inhibitive paint, style of door to suit wall, ceiling, floor or roof construction and fire rating.
      a. Milcor Type M
      b. Milcor Type UFR, fire resistive type Underwriters Laboratory Class B, 1-1/2 hour rating meets UBC, IBCO and BOCA codes for two hour rated walls self latching with key lock, Elmdor/Stonman Type FR or equal.

2. Minimum size; 18" by 18".

3. Wall and ceiling access doors: Furnish as required for access to ducts, damper operators, duct mounted access panels, etc.; coordinate size and location to obtain access.

4. See architectural drawings for further requirements.

2.7 IDENTIFICATION

A. Equipment: Black Phenolic Plates engraved with 1/2" high white letters. The equipment shall be identified by the mechanical equipment schedule tag numbers shown on the plans (ie. GWH-1; CP-1 etc.). Coordinate identification numbers with electrical contractor to ensure that the disconnect switches and other electrical/mechanical equipment has consistent identification numbers.

B. Controls: Same as equipment above except 1/4" high letters.

2.8 MISCELLANEOUS EQUIPMENT AND MATERIALS

A. Furnish and install miscellaneous equipment and materials required for the systems described whether or not specifically shown or specified.
PART 3 - EXECUTION

3.1 ACCESSIBILITY

A. Do not install any equipment, valve, control, motor, filter, or any other device requiring maintenance or service in an inaccessible location or position. Install access doors as specified herein to render all such equipment serviceable whether specifically shown on the plans or not. Maintain code clearance to all equipment. Coordinate location of doors with lights, etc., and locate symmetrically with same.

3.2 PREPARATION

A. Observations: Check all project drawings and specifications; report any discrepancies before proceeding with the work and in time to avoid unnecessary rework.

B. Investigation: Examine the areas, conditions, and status of other work contiguous or connecting to the work to be performed; ensure that the time of installation is coordinated with other work.

C. Interruptions of Service: Portions of this work may involve connection to existing work, facilities, or utilities ties and may require interrupting shutdowns of same. Carefully plan, coordinate and execute such work so that any interruptions will be kept to a minimum in time and occurrence. Submit request for shutdowns and make shutdowns only after receiving written approval from the Owner.

D. Other: Correct any unsatisfactory conditions that may impede proper execution of the work. Ensure that all arrangements, personnel, materials, and tools are appropriate and adequate before proceeding.

3.3 INSTALLATION

A. General:

1. Material and equipment incorporated in the work shall be used or applied only for the purpose intended or specified.

2. Install piping and ductwork and all equipment that requires access with minimum vertical and horizontal clearances required by OSHA for service.

3. All mechanical systems such as ductwork, pipes and all other equipment shall have 2 inches minimum clearance.

4. Do not proceed with work without clear understanding.

B. Manufacturer's Instructions:

1. When specifications require that installation comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation.

2. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by specifications.

3. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.

4. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with the Engineer for further instructions.
5. Do not proceed with work without clear understanding.

3.4 DEMOLITION

A. General

1. Procedures shall be determined by the contractor.

2. Demolition work shall not be commenced until all temporary work such as fences, barricades, and any required warning lights and apparatus are furnished and installed and as required by law, regulation, or ordinance, or elsewhere in this specification.

3. Demolition work shall proceed in such a manner as to minimize the spread of dust and flying particles and to provide safe working conditions for personnel.

4. Fires and explosives shall not be permitted.

B. Protection

1. Contractor shall conform to all Federal, State, and local ordinances related to the protection of the public and Contractor’s personnel and the flow of traffic. Provide protection for persons and property throughout the progress of the work.

2. Existing work damaged by the contractor in the execution of this Contract shall be restored to former condition by the contractor to the satisfaction of the Owner without an increase in the Contract Sum and without an extension of the Contract Time.

C. Disposition of Materials

1. All materials and equipment not scheduled to be salvaged, including debris and all rejected salvaged materials, shall become the property of the Contractor and shall be disposed of off site in a legal manner. Location of dump and length of hall shall be the contractor’s responsibility.

3.5 LOCATION OF EQUIPMENT, PIPING AND DUCT WORK

A. Where job conditions do not permit the installation of piping, ductwork, etc. in the location shown, it shall be brought to the engineer’s attention immediately before fabrication of ductwork, piping, etc. and the relocation required shall be determined in a joint conference.

B. The contractor will be held responsible for the relocating of any items installed without first obtaining the architect’s or engineer’s approval. Remove and relocate such items at the contractors expense as so directed by the architect or engineer.

C. Where piping or ducting is left exposed within a room, run in vertical or horizontal planes. Maintain uniform spacing between parallel lines and/or adjacent wall, floor or ceiling surfaces.

D. Horizontal runs of plumbing and/or electrical conduit suspended from ceilings shall provide for maximum clearance.

E. Make minor changes in locations of equipment, piping, ducts, etc. from locations shown including minor offsets when directed by the engineer, at no additional cost to the owner.

3.6 CARE AND CLEANING

A. Clean and adjust all equipment at completion of installation to provide operating conditions satisfactory to the engineer. Remove broken, damaged or defective parts; repair or replace
as directed by engineer. Remove surface material and debris resulting from this work when directed.

3.7 EQUIPMENT AND CONTROL IDENTIFICATION

A. Identify all equipment with permanently attached plates.

B. Identify all controls and controllers except thermostats in finished areas.

3.8 FLASHINGS

A. Furnish and install a waterproof flashing for each pipe, duct, or other penetration through roof or wall. Flashings shall be 4 lb. seamless lead flashings Semco 1100 series with counter flashing as detailed, except in metal roofs flashing for pipes through roof shall be furnished by the roofing contractor. Where details are not specifically delineated, submit details for review.

3.9 PAINTING

A. Painting is included under the Painting and Finishing Section. It shall be the responsibility of the Mechanical Contractor to properly protect all equipment and controls during painting operations and the Mechanical Contractor shall repair and/or replace any item damaged due to painting that was not properly protected.

3.10 ACCESS DOORS

A. Provide access doors to all concealed equipment, valves, controls, etc. Locate doors where shown or to be coordinated and symmetrically located with lights, diffusers, etc. Access doors furnished by the mechanical contractor shall be installed by the general contractor.

3.11 OPERATION AND MAINTENANCE DATA

A. General: Record data and operation and maintenance data are complementary. Submittal items which may be required under both categories may be included only under one submittal if a statement to that effect is included in the other submittal.

B. Quality Assurance

1. Preparation of data shall be done by personnel
   a. Trained and experienced in maintenance and operation of described products.
   b. Familiar with requirements of this Section.
   c. Skilled as technical writer to the extent required to communicate essential data.
   d. Skilled as draftsman competent to prepare required drawings.

C. Form of Submittals

1. Prepare data in form of an instructional manual for use by Owner's personnel.
   a. Cover: Identify each volume with typed or printed title, "OPERATING AND MAINTENANCE INSTRUCTION". List:
   b. Title of Project
   c. Provide indexed tabs.
   d. Identity of separate structure as applicable.
   e. Identity of general subject matter covered in the manual.
2. Format  
   a. Size: 8-1/2 in. x 11 in.  
   b. Paper: 20 pound minimum, white, for typed pages.  
   c. Text: Manufacturer's printed data, or neatly typewritten.  

3. Drawings  
   a. Provide reinforced punched binder tab, bind in with text.  
   b. Fold larger drawings to size of text pages.  

4. Provide fly-leaf for each separate product, or each piece of operating equipment.  
   a. Provide typed description of product, and major component parts of equipment.  
   b. Provide indexed tabs.  

5. Binders  
   b. Maximum ring size: 1 inch.  
   c. When multiple binders are used, correlate the data into related consistent groupings.  

D. Content of Manual  
1. Neatly typewritten table of contents for each volume, arranged in systematic order.  
   a. Contractor, name of responsible principal, address and telephone number.  
   b. A list of each product required to be included, indexed to content of the volume.  
   c. List, with each product, name, address and telephone number of:  
      1) Subcontractor or installer.  
      2) Maintenance contractor, as appropriate.  
      3) Identify area of responsibility of each.  
      4) Local source of supply for parts and replacement.  
      5) Identify each product by product name and other identifying symbols as set forth in Contract Documents.  

2. Product Data  
   a. Include only those sheets which are pertinent to the specific product.  
   b. Annotate each sheet to:  
      1) Clearly identify specific product or part installed.  
      2) Clearly identify data applicable to installation.  
      3) Delete references to inapplicable information.  

3. Drawings  
   a. Supplement product data with drawings as necessary to clearly illustrate.  
      1) Relations of component parts of equipment and systems.  
      2) Control and flow diagrams.  
   b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.  
   c. Do not use Project Record Documents as maintenance drawings.
4. Written text, as required to supplement product data for the particular installation.
   a. Organize in consistent format under separate headings for different procedures.
   b. Provide logical sequence of instructions for each procedure.

   a. Provide a factory start-up report for each piece of equipment. Contractor start-up reports, unless contractor is a factory authorized representative will not be allowed.

6. Copy of each warranty, bond and service contract issued.
   a. Provide information sheet for Owner's personnel, give:
      1) Proper procedures in event of failure.
      2) Instances which might affect validity of warranties or bonds.

E. Manual for Equipment and Systems

1. Submit three copies of complete manual in final form.
   a. Content, for each unit of equipment and system, as appropriate.
      1) Description of unit and component parts.
      2) Function, normal operating characteristics, and limiting conditions.
      3) Performance curves, engineering data and tests.
      4) Complete nomenclature and commercial number of replaceable parts.
      5) Operating procedures
      6) Start-up, break-in, routing and normal operating instructions.
      7) Regulation, control, stopping, shut-down and emergency instructions.
      8) Summer and winter operating instructions.
      9) Special operating instructions.
     10) Maintenance Procedures
     11) Routing operations
     12) Guide to "trouble-shooting".
     13) Disassembly, repair and reassembly.
     14) Alignment, adjusting and checking
     15) Servicing and lubrication schedule.
     16) List of lubricants required.
     17) Manufacturer's printed operating and maintenance instructions.
     18) Description of sequence of operation by control manufacturer.
     19) Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
     20) Predicted life of parts subject to wear.
     21) Items recommended to be stocked as spare parts.
     22) As-installed control diagrams by controls manufacturer.
     23) Each contractor's coordination drawings.
     24) As-installed color coded piping diagrams.
25) Charts of valve tag numbers, with location and function of each valve.
26) List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
27) Other data as required under pertinent sections of specifications.
28) Content, for each electric and electronic system, as appropriate.
29) Description of system and component parts.
30) Function, normal operating characteristics, and limiting conditions.
31) Performance curves, engineering data and tests.
32) Complete nomenclature and commercial number of replaceable parts.
33) Circuit directories of panel boards.
34) Electrical service.
35) Controls.
36) Communications
37) As-installed color coded wiring diagrams.
38) Operating procedures:
39) Routing and normal operating instructions.
40) Sequences required
41) Special operating instructions
42) Maintenance procedures
43) Routine operations
44) Guide to "trouble-shooting".
45) Disassembly, repair and reassembly.
46) Adjustment and checking.
47) Manufacturer's printed operating and maintenance instructions.
48) List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
49) Other data as required under pertinent sections of specifications.
50) Additional requirements for operating and maintenance data: Respective sections of Specifications.

F. Submittal Schedule
1. Submit two copies of preliminary draft of proposed formats and outlines of contents prior to start of work.
   a. Architect will review draft and return one copy with comments.
2. Submit one copy of complete data in final form fifteen days prior to final inspection or acceptance.
   a. Copy will be returned after final inspection or acceptance, with comments.
3. Submit specified number of copies of approved data in final form 10 days after final inspection or acceptance.

G. Instruction of Owner's Personnel
1. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems.

2. Operating and maintenance manual shall constitute the basis of instruction.
   a. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

3.12 RECORD DATA

A. Compilation
   1. Record and collect information concurrently with construction progress and date all entries; make drawing entries within 24 hours after occurrence of change or installation requiring recording. Any concealed work covered before recording data shall be uncovered as directed or as necessary to obtain data.
      a. Record information on drawing prints using an erasable colored pencil (not ink or indelible pencil); describe clearly by note or graphic line as appropriate.
   2. Locate any concealed work adequately to allow future access with reasonable ease and accuracy.
      a. Identify the plan location of all stub outs, pipe lines, etc., which are buried or concealed in the structure, whether installed where shown on the contract drawings or in a different location; show actual field dimensions from column lines, wall lines, or other permanent reference lines or points.
      b. In many cases on the contract drawings, the arrangement of conduits, pipes, ducts, and similar items is shown schematically rather than as a precise scaled layout. Identify the actual location of these with horizontal and vertical dimensions. If such lines are exposed or readily accessible, omit dimensional identification.
      c. When any work is installed of size, dimension, slope, or location different from that shown on the contract drawings, note the deviation on the Project Record set. If the variations are substantial or cannot be shown clearly on the record drawings, make a new drawing and attach to the Record set.
   3. On other documents
      a. Where changes occur in specifications, clearly indicate same in ink, colored pencil, or rubber stamp.
      b. Where installed equipment differs from that specified (e.g., by accepted substitution or change order) note in the specifications and include complete data on same.

3.13 OPERATION AND MAINTENANCE DATA

A. Preparations: Prior to data collection and compilation, prepare and submit in duplicate an outline of the proposed organization and content.

B. Compilation: Prepare and collect data concurrently with construction progress. Compile per submitted outline.

C. See Section 22 01 00 Operation and Maintenance of Plumbing.

END OF SECTION
SECTION 22 05 13
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. All Division 22 Sections.

1.2 SUMMARY
A. Furnish and install all mechanical work shown on the drawings, specified herein, and as required for a complete and functional installation.

B. This section includes materials and methods applicable to the work described in all Division 15 Mechanical Sections. Specific work requirements of individual Mechanical Sections take precedence if in conflict with requirements of this Section.

1.3 RELATED SECTIONS
A. Division 3 - Concrete Work
B. Division 26 - Electrical Work
C. Division 23 - HVAC
D. Division 21 - Fire Sprinkler

PART 2 - PRODUCTS

2.1 MOTORS AND STARTERS
A. Motors furnished as part of mechanical equipment shall be of size indicated and shall have starting torque sufficient to start and drive equipment load to which they are connected.

B. Electric motors shall be NEMA Premium efficiency, Gould "E 3Plus," or equal. Provide motors with maximum efficiency and power factor at their normal load operating point.

C. Motor enclosures shall be:
D. Open drip proof for general use.
E. Totally enclosed for wet or exterior use.
F. Explosion-proof for hazardous location use.

G. Electric Motors of ¾ HP rating and over, heavy duty, ball bearing, open (drip-proof), squirrel cage induction type, normal starting torque 60 cycle service, 40°F continuous rating, and shall conform in all respects to the latest applicable standard of NEMA and AIEE. Motors up to ¾ HP rating shall have sleeve or ball bearing. Electric motors which are not housed within equipment they serve, shall be stamped for Quiet-Operation. Motors shall be of an Energy Efficient design meeting C.E.C., Title 24.
H. Motor starters and contactors except those in motor control centers shall be included in the mechanical work.

I. Starters: Starters furnished integral to, or specifically for, mechanical equipment shall be Square D, General Electric, Cutler-Hammer, or equal and shall comply with the following:

1. Enclosures shall be NEMA Standard to suit location/duty:
   a. Type 1: general purpose.
   b. Type 3: rain tight.
   c. Type 4: watertight.
   d. Type 7&9: explosion proof.

2. Thermal overload protection devices shall be provided as follows:
   a. One for single-phase motors.
   b. Three for three-phase motors.
   c. One for each ungrounded conductor for each winding of multi-wound or multi-speed motors.

3. Starters for motors up to 1/2 HP may be manual type if no interlocking is required; pilot light to indicate ON position is required.

4. Starters for motors up to 30 HP shall be magnetic across-the-line type except as stipulated above.

5. Starters for motors over 30 HP shall be transition-type magnetic-reduced voltage unless specified otherwise. Coordinate the characteristics to ensure adequate starting torque and to limit the starting current to a level compatible to the electrical system and acceptable to the utility company/agency.

6. Magnetic starters shall be provided with:
   a. 120 volt control circuits.
   b. H-O-A switch in cover.
   c. Auxiliary contacts for necessary interlocking.
   d. Integral disconnect switch or circuit breakers for branch circuit, short-circuit and ground-fault protection.

7. Short-circuit interrupting capacity of starters and disconnects shall be adequate for voltage employed and for current to be interrupted. This may require use of high interrupting capacity breakers or current limiting fuses. If fuses are used, provide three spares for each disconnect.

8. Starters shall be compatible with the motor they control.

PART 3 - EXECUTION

3.1 ELECTRICAL REQUIREMENTS

A. Provide working space around electrical equipment in compliance with the applicable Code and all Safety Orders.

B. Coordinate the Mechanical Work with the Electrical Work to comply with the above. Furnish and set in place all motors and duct or pipe installed controls.
C. Location of all new switches shall be verified with the architect or architect before roughing-in. Furnish necessary control diagrams and instruction for the proper installation of the controls.

D. Assume responsibility to insure that all motors are connected with flexible conduit per Division 26 requirements.

E. Assume responsibility for the proper supervision and testing of the controls for sequence of operation.

F. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers Association.

G. All equipment electrical characteristics shall be as noted on the drawings, or as specified. Verify before ordering any equipment.

H. Before permitting operation of any equipment which is furnished, installed or modified under this contract, review all wiring connections that pertain to mechanical equipment or work, and verify that these connections are correct.

I. Ascertaining that the over-load protection devices installed are of the correct type, rating and setting to properly protect this equipment.

J. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize mechanical equipment wiring diagrams to coordinate with the electrical systems so that proper wiring of the equipment involved is affected:

END OF SECTION
SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. All Division 22 Mechanical Sections.

1.2 SUMMARY
   A. See Section 22 05 00

1.3 RELATED SECTIONS
   A. Division 3: Concrete Work
   B. Division 26: Electrical Work
   C. Division 23: HVAC
   D. Division 21: Fire Suppression

PART 2 - PRODUCTS

2.1 GENERAL
   A. Furnish two tee handle operators for each size to suit all valves which are installed below
      grade in access boxes and which are not fitted with integral handles; hub end valves shall
      be used where required.
      1. Valves on systems operating over 100 psi shall be rated for 150 psi or higher as required.
   B. Shut-off service, domestic water
      1. Ball Valves:
         a. Sizes 2" and smaller: Nibco T-685-80-LF, 600 psi rated, threaded or sweat ends, full
            port, teflon seat, quarter turn handle with stops, two piece bronze body.
         b. Sizes 2-1/2 to 4": Nibco T-FP-600A-LF, 400 psi rated, soldered ends, full port, teflon
            seat, quarter turn handle with stops, two piece bronze body.

2.2 VALVE BOXES
   A. Underground valve box shall be "Brooks or "Christy" marked for service.

PART 3 - EXECUTION

3.1 GENERAL
   A. Valves shall be full size of line in which installed. Furnish discs suitable for service intended.
      All valves shall be properly packed and lubricated. Unions shall be placed adjacent to each
threaded or soldered valve or equipment connection 2" and smaller. Install flanges at all valves with stems vertical wherever possible. Stems shall not be placed below horizontal.

B. Install unions adjacent to each valve and at final connection to each piece of equipment.

C. All shutoff valves in water lines shall be or ball valves, unless otherwise shown.

D. Valves shall be provided with brass identification tags indicating service controlled. Tags may be omitted on lines exposed in equipment rooms where service is obvious.

END OF SECTION
SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All Division 23 Mechanical Sections.

1.2 SUMMARY

A. Furnish and install all mechanical work shown on the drawings, specified herein, and as required for a complete and functional installation.

B. This section includes materials and methods applicable to the work described in all Division 23 Mechanical Sections. Specific work requirements of individual Mechanical Sections take precedence if in conflict with requirements of this Section.

1.3 SUBMITTALS

A. Submit proposed alternative methods of attachment for review and approval by the Engineer, prior to deviating from the requirements given below.

B. For all seismic bracing systems, submit structural calculations and details prepared and signed by the Contractor's licensed engineer which include all resultant forces applied to the building structure. Do not overstress building structure. The maximum allowable loads are as indicated in 3.01 of this specification. The submittal data required does not require an analysis of the building structural numbers and their reaction to the loads of the piping. The submittal data needs to address attachment methods and shall include calculations indicating the forces that are applied to the building structure at the point of attachment. Calculations will be reviewed for compliance with design criteria, not for arithmetic.

1.4 RELATED SECTIONS

A. Division 3: Concrete Work

B. Division 26: Electrical Work

C. Division 23: HVAC

D. Division 21: Fire Suppression

1.5 DRAWINGS AND SPECIFICATIONS

A. Information presented on Drawings and in the Specifications is based upon latest data available during their preparation. The Drawings and Specifications are for the assistance and guidance of the Contractor and exact locations, distances, levels, etc. will be governed by the structures and the site the contractor shall accept same with this understanding.
PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

A. B-Line, Superstrut, Tolco, Grinnell, or equal. Numbers are B-line.

B. Finish: Electro-Chromate or hot dipped galvanized.

C. Individual: B3690, B3100 cleaves or B3110 with H-104 all thread rod. Use B3110 for pipe subject to movement.

D. Trapeze Suspension, for three or more pipes B-Line 1-5/8" width channel or a size suitable for load in accordance with manufacturer's published load ratings. No deflection to exceed 1/180 of a span.

E. Trapeze Supporting Rods: Diameter sufficient to support the load with a safety factor of 5. Anchor rods securely to building structure. See part three for minimum sizes.


G. Size: For insulated pipe - B3690 pipe hangers sized to allow pipe insulation to pass continuously through the hanger.

H. Insulated Pipe Shields: Utilize isolated pipe supports at all insulated pipe hanger locations.

I. Isolators: 319CT or Trisolator isolators at all hangers and clamps supporting un-insulated piping and tubing and at all points that pipe comes in contact with structure or other pipes.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

A. General: Support all piping so that it is firmly held in place by approved iron hangers and supports and special hangers as required or as scheduled on the drawings.

1. Rigidly fasten hose faucets, and similar items at ends of pipe branches to the building construction near point of connection.

B. Hanger Installation: On all insulated pipes, install the hangers on the outside of the pipe covering and not in contact with the pipe. Burning, welding, cutting, or drilling on any structural member may only be done if approved by the structural engineer. No valve or piece of equipment shall be used to support the weight of any pipe. Provide a hanger close to the point of change of direction of pipe run in either horizontal or vertical plane. Place supports and hangers for cast iron soil pipe as close as possible to joints; when hangers or supports do not come within one foot of a branch line fitting, install an additional hanger or support at the fitting. Protect insulation, when pipe is insulated, at each hanger with 180 degree, 18 gauge, 12 inch long G.I. Saddles.

C. Hanger rods with C-clamp type structural attachment shall be equipped with retaining straps.
D. Metallic Pipe Hanger Spacing and Rod Size Schedule:

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Size</td>
<td>1½&quot; – 2&quot;</td>
</tr>
<tr>
<td></td>
<td>2 ½&quot; – 5&quot;</td>
</tr>
<tr>
<td></td>
<td>6&quot; – 8&quot;</td>
</tr>
<tr>
<td>Steel Pipe</td>
<td>*8' - 0&quot;</td>
</tr>
<tr>
<td></td>
<td>10' - 0&quot;</td>
</tr>
<tr>
<td></td>
<td>12' - 0&quot;</td>
</tr>
<tr>
<td>Copper Tubing</td>
<td>5' - 0&quot;</td>
</tr>
<tr>
<td></td>
<td>10’ – 0”</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>Support at 8’- 0&quot; intervals and on each side of and within 12&quot; of joint.</td>
</tr>
<tr>
<td>Rod Size:</td>
<td>3/8”</td>
</tr>
</tbody>
</table>

*1/2" gas piping shall be spaced 6’ – 0” maximum

E. Anchor pipe subject to expansion or contraction in a manner permitting strains to be evenly distributed.

F. All hangers and fasteners are subject to the approval of the Structural Engineer.

G. Provide beam clamp retaining straps for all pipe supports attached to structural beams.

END OF SECTION
SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, SPECIAL CONDITIONS and DIVISION 1 GENERAL REQUIREMENTS, apply to the work of this section.

B. All Division 23 Mechanical Sections.

1.2 SUMMARY

A. See 22 05 00

1.3 RELATED SECTIONS

A. Division 3: Concrete Work.

B. Division 26: Electrical Work.

C. Division 23: HVAC.

D. Division 21: Fire Suppression.

1.4 SEISMIC RESISTANCE

A. Furnish and install all systems, units, equipment, and parts to meet or exceed current applicable requirements for seismic resistance specified by codes, regulations, or agencies having jurisdiction. Include all supports, anchors, braces and other restraining devices required. All seismic restraints will meet the following site specific seismic design criteria:

1. Seismic Design Category D, 2) Importance Factor, $I_P = 1.0$ except $I_P = 1.5$ for fire sprinklers; and 3) $SDS = 1.64$

2. Seismic restraints are the responsibility of the contractor.

B. Design of seismic bracing shall meet requirements of CBC Chapter 16A.

C. All mechanical equipment shall be anchored or braced to meet the horizontal and vertical forces prescribed in the 2016 CBC.

D. The attachment of the following items shall be designed to resist the forces prescribed in Section the 2016 CBC but, need not be detailed on the plans.

E. Equipment weighing less than 400 pounds supported directly on the floor or roof.

F. Furniture required to be attached in accordance with Part 2, Title 24, C.C.R..

G. Temporary or movable equipment.

H. Equipment weighing less than 20 pounds supported by vibration isolators.
I. Equipment weighing less than 20 pounds suspended from a roof or floor or hung from a wall.

J. For those elements that do not require details on the approved drawings, the installation shall be subject to the approval of the Mechanical Engineer and the field representative of the Division of the State Architect.

K. Copies of the manual shall be on the jobsite prior starting hanging and bracing of the pipe and ductwork systems.

L. The structural engineer shall verify the adequacy of the structure to support the hanger and brace loads.

PART 2 - PRODUCTS

2.1 BRACING SYSTEMS

A. Provide approved types as manufactured by Mason West, B-Line, Tolco or equal.

PART 3 - EXECUTION

3.1 SWAY BRACING

A. Provide earthquake sway bracing in accordance with 2016 CBC and approved OPM details.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section describes insulation materials, methods, and applications for Mechanical Work. Special or specific details, applications, features, or methods may be described in work descriptions Sections or on the drawings.

1.2 RELATED DIVISIONS

A. 01 00 00: General Requirements
B. 21 00 00: Fire Sprinklers
C. 22 00 00: Plumbing
D. 23 00 00: HVAC

1.3 REFERENCES

A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:
   1. American Society for Testing of Materials Specifications:
      b. ASTM C 585, "Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)"
      c. ASTM C 1136, "Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation"

1.4 SYSTEM PERFORMANCE


B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of applicable building codes when tested in composite form per one of the following nominally equivalent test methods:
   1. American Society for Testing of Materials   ASTM E 84
   2. Underwriters' Laboratories, Inc. UL 723, CAN/ULC-S102-M88

C. Molded pipe insulation shall be manufactured to meet ASTM C 585 for sizes required in the particular system.

D. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547.
1.5 QUALITY ASSURANCE

A. Qualifications of Installers: only a licensed firm employing installers specifically skilled and experienced in applying insulation to piping shall do Insulation work.

B. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers’ current submittal or data sheets showing compliance with applicable specifications listed in above.

C. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

D. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

E. Codes and Standards:

2. National Fire Protection Association - 90A
3. Insulation applied to the exterior or interior surface of ducts, and the exterior surface of piping, shall be UL labeled with maximum flame-spread rating of 25 and maximum smoke-developed rating of 50 according to ASTME 84, when tested as a composite installation including insulation, facing materials, and adhesives as normally applied.

1.6 DELIVERY AND STORAGE OF MATERIALS

A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way.

C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the contractor is able to demonstrate that wet insulation when fully dried out (either before installation or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance.

PART 2 - PRODUCTS

2.1 PLUMBING EQUIPMENT INSULATION – SEE 22 07 16

2.2 PLUMBING PIPING INSULATION – SEE 22 07 19

PART 3 - EXECUTION

3.1 APPLICATION/INSTALLATION

A. Use the types and thickness of insulation specified in work description Sections.
B. Apply insulations in accordance with the manufacturer's recommendations and with instructions specified herein or noted on the drawings.

C. Install insulations only after the systems, items, and equipment have been installed and tested, inspected, and accepted. Exceptions: Slip-on piping insulation and equipment insulations installed at the factory.

D. Fit insulation snugly to the item being insulated; butt all joints tightly with no voids, spaces, or thin spots.

E. Seal all joints completely; where sealing tape is used, center the tape over the joint.

F. Except where specified or necessary, do not use staples or fasteners which penetrate vapor barrier jackets or covers on cold systems or equipment; where such penetrating fasteners are used, seal each penetration completely to maintain the vapor barrier integrity. All penetrations of the ASJ and exposed ends of insulation shall be sealed with vapor barrier mastic. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

G. Use adhesives, mastics, cements, sealants, and finishes undiluted unless specifically directed otherwise; apply per manufacturer's directions.

H. Install outdoor jacketing or other specified weather proofing or finishing on all insulations outdoors.

I. Install all indoor exposed insulation with extra care and finish neatly.

J. Follow specified methods of installation unless alternative methods are submitted and approved.

3.2 FINISHING

A. Finishes and Protection:
   1. Insure that the exterior finish of all insulation is applied and complete as specified.
   2. Make ready for painting, or painted to match existing including color where specified for paint.
   3. Install all metal jackets or protective sheathing where specified.

B. Repair, Touchup: Properly repair and touchup all dents, rips, tears, or other damage inflicted on jackets or exterior surfaces of insulation. Breaks or punctures in the vapor barrier of external insulation will not be accepted and must be repaired prior to project acceptance.

END OF SECTION
SECTION 22 07 16
PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL
1.1 SEE 22 07 00 AND 22 07 19

PART 2 - PRODUCTS
1.1 SEE 22 07 19

PART 3 - EXECUTION
1.1 APPLICATION
   A. Equipment/Tanks
      1. Use System IP3 (Elastomeric Foam)
      2. 3/4" thickness for all sizes.

END OF SECTION
SECTION 22 07 19
PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. A continuous intact vapor barrier is critical for all pipes conveying fluids at temperatures less than 75° F.

B. All insulation material shall have a mold, humidity, and erosion resistant face that has met the requirements of 2016 CMC Standard No. 6-1.

C. Insulation applied to the exterior surface of pipes located in buildings shall have a flame spread of no more than 25 and smoke developed rating of not more than 50.

D. All requirements of Section 22 07 00 apply to this section.

PART 2 - PRODUCTS

2.1 IP-1 RIGID MOLDED SECTIONAL/INDOOR CONCEALED JACKET

A. Regular shape (straight run):

1. Molded sectional, factory fabricated of heavy density resin bonded fibrous glass, with integral factory applied all service jack of Kraft paper/aluminum foil/glass fiber reinforcement.

2. Insulation shall have a thermal conductivity k factor of 0.23 at 75° F mean temperature and be suitable for direct application and service on piping having operating surface temperatures of -60° to 450°F.

3. Jacket shall:
   a. Extend 1-1/2" (minimum) along one edge of longitudinal joint to form a sealing lap, which shall be faced inside with a paper protected pressure sensitive adhesive.
   b. Have a permanence rating of 0.02 perm/in. and a Beach puncture resistance of 50 units;
   c. Have an exterior suitable for painting with latex or water base paint.

4. All insulation shall have composite (insulation, jacket, tape seal and adhesive used to adhere jacket to the insulation). Fire and Smoke Hazard ratings as tested under procedure ASTM E-84, NFPA 255 and UL 723, not exceeding Flame Spread of 25 and a Smoke Developed of 50. PVC fitting covers and accessories, such as adhesives, mastics, cements and cloth for fittings shall have the same component ratings.

5. Paper laminate jackets shall be permanently flame and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity.

6. Fiberglass Schuler-Manville Micro-Lok, or equal.

B. Irregular shape (fittings, flanges, valves, etc.)
1. Fibrous glass of same density, thickness, and other properties or characteristics as the adjacent regular shape insulation either pre-molded or field forged to fit the item being insulated. The pre-molded insulation shall be provided with weather protection cover.

2.2 IP-2 RIGID MOLDED SECTIONAL/OUTDOOR JACKET

A. Regular shape (straight run).
   1. Molded sectional, factory fabricated of heavy density resin bonded fibrous glass, with integral factory applied all service jacket of Kraft paper/aluminum foil/glass fiber reinforcement.
   2. Insulation shall have a thermal conductivity k factor of 0.23 at 75°F mean temperature and be suitable for direct application and service on piping having operating surface temperatures of -60°F to 450°F.
   3. Jacket:
   5. Irregular shapes:
      a. Amerisafe, factory molded aluminum covers, or
      b. Mitered aluminum sheet matching straight run jacketing, or
      c. Weather coating.
      d. Alternative jacketing: Schuler-Manville Type ML, metal jacketing system.
   6. All insulation shall have composite (insulation, jacket, tape seal and adhesive used to adhere jacket to the insulation). Fire and Smoke Hazard ratings as tested under procedure ASTM E-84, NFPA 255 and UL 723, not exceeding Flame Spread of 25 and a Smoke Developed of 50. PVC fitting covers and accessories, such as adhesives, mastics, cements and cloth for fittings shall have the same component ratings.
   7. Paper laminate jackets shall be permanently flame and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity.
   8. Fiberglass Schuler-Manville Micro-Lok, or equal.

B. Irregular shape (fittings, flanges, valves, etc.)
   1. Fibrous glass of same density, thickness, and other properties or characteristics as the adjacent regular shape insulation, either pre-molded or field forged to fit the item being insulated. The pre-molded insulation shall be provided with weather protection cover.

2.3 IP-3 ELASTOMERIC FOAM

A. Insulation shall be Elastomeric Foam Insulation. Insulation should have a maximum service temperature of 210°F, a minimum service temperature of -40°F, and a “K” factor of 028 at 75°F. The flame spread of the insulation shall be 25 or less, and smoke density shall be 50 or less when tested in accordance with ASTM E84.

B. Provide U.V. protective coating for all outdoor applications. Foster 30-64, Armacell WB Coating or K-Flex 374.

C. K-Flex R-180-FS/R-1800-FS, Armacell Armaflex or equal.
2.4 IP-4 CLOSED CELL POLYOLEFIN

A. Closed cell flexible plastic foam insulation should have a “k” factor of 0.27 or less at 75°F and water vapor permeability of .2 perm-inch or less. The manufacturer shall warrant the insulation to be able to be directly buried underground without any protective jacket.


C. Provide U.V. protective coating for all outdoor applications.

D. IMCOA Imcolock or equal.

2.5 IP-5 RIGID MOLDED SECTIONAL/INDOOR EXPOSED JACKET

A. Regular shape (straight run)

1. Molded sectional, factory fabricated of heavy density resin bonded fibrous glass, with integral factory applied all service jacket of Kraft paper/aluminum foil/glass fiber reinforcement.

2. Insulation shall have a thermal conductivity k factor of 0.23 at 75°F mean temperature and be suitable for direct application and service on piping having operating surface temperatures of -60° to 450°F.

3. Jacket:
   a. Straight runs: PVC fitting covers with vapor barrier.
   b. Irregular shapes:
      c. Zeston, Snap-Form, factory molded PVC covers, or
      d. Mitered aluminum sheet matching straight run jacketing, or
   e. Alternative jacketing: Schuler-Manville Type ML, metal jacketing system.

4. All insulation shall have composite (insulation, jacket, tape seal and adhesive used to adhere jacket to the insulation). Fire and Smoke Hazard ratings as tested under procedure ASTM E-84, NFPA 255 and UL 723, not exceeding Flame Spread of 25 and a Smoke Developed of 50. PVC fitting covers and accessories, such as adhesives, mastics, cements and cloth for fittings shall have the same component ratings.

5. Paper laminate jackets shall be permanently flame and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity.

6. Fiberglass Schuler-Manville Mico-Lok, or equal.

B. Irregular shape (fittings, flanges, valves, etc.)

1. Fibrous glass of same density, thickness, and other properties or characteristics as the adjacent regular shape insulation, either pre-molded or field forged to fit the item being insulated. The pre-molded insulation shall be provided with PVC protection cover.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

Note: Where multiple systems are listed, contractor has the option to choose.
A. Condensate (CD) water piping above grade/indoors
      a. 3/4" thickness for all sizes
   2. Use System IP-4. (Closed Cell Polyolefin).
      a. 3/4" thickness for all sizes
   3. Use System IP-1. (Rigid Molded Sectional/Indoor Jacket) with vapor barrier.
      a. 3/4" thickness for all sizes

B. Rain Water Leaders and Overflow Drains above grade/indoors:
      a. 3/4" thickness for all sizes
   2. Use System IP-4. (Closed Cell Polyolefin).
      a. 3/4" thickness for all sizes
   3. Use System IP-1. (Rigid Molded Sectional/Indoor Jacket) with vapor barrier.
      a. 3/4" thickness for all sizes

C. Domestic cold water (CW) piping above grade/outdoors
   1. Use System IP-2. (Rigid Molded Sectional/Outdoor Jacket) with vapor barrier.
      a. 1 1/2" thickness for all sizes
      b. All piping shall have heat trace installed to protect from freezing. Coordinate with the electrical contractor.

D. Domestic tempered water (TW) above grade/indoors
   1. Use System IP-1. (Rigid Molded Sectional/Indoor Jacket) with vapor barrier.
      a. 1/2" thickness for pipes smaller than 1" diameter, 1" thickness for 1" diameter through 2" diameter and 1 1/2" thickness for 2 1/2" to 6" diameter, use 2" thick for all larger piping.

E. Domestic hot water (HW) above grade/indoors
   1. Use System IP-1. (Rigid Molded Sectional/Indoor Jacket) with vapor barrier.
      a. 1/2" thickness for pipes smaller than 1" diameter, 1" thickness for 1" diameter through 2" diameter and 1 1/2" thickness for 2 1/2" to 6" diameter, use 2" thick for all larger piping.

F. Domestic hot water (HW) above grade/outdoors
   1. Use System IP-2. (Rigid Molded Sectional/Outdoor Jacket) with vapor barrier.
      a. All Sizes: 2" thick.

3.2 INSTALLATION

A. Unless specifically excluded herein or on the drawings, insulate all parts of hot piping systems, steam piping, and condensate drains including fittings, flanges, valves, and pipe-mounted devices, except do not cover nameplates on devices.

B. Install insulation in removable sections over unions, flanges, and line components or devices requiring periodic maintenance.
C. Install insulation butted tightly to transitions such as insulated pipe shields, insulated pipe sleeves, equipment connections, etc.

D. Install insulation on piping systems so that condensation will not occur. Insulate pipe supports where hanger is directly in contact with pipe up to the point of connection to the building structure. All piping shall be supported in such a manner that neither the insulation nor the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing shall be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier shall be continuous, including material covered by the hanger saddle.

E. Treat equipment face piping as follows:
1. Where piping is subject to condensation (domestic water systems, rain water leaders, condensate drains) and where installed above grade outdoors (either hot or cold systems) insulate piping completely to the point of equipment connection.
2. Where not subject to condensation (hot systems) terminate insulation at the outlet side of the equipment shut-off valve, leaving the face piping un-insulated, 24” max, unless noted otherwise, except where exposed to outdoors.

F. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.

G. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with Foster 30-65 or Childers CP-34 vapor barrier coating to maintain vapor barrier integrity.

H. Rigid Molded Sectional/Jacketed:
1. Comply with applicable general instructions above.
2. Apply to all hot water and piping (except where specified or noted otherwise) installed above grade indoors and outdoors, concealed or exposed.
3. Seal all transverse joints (except at PVC fitting jackets) with circumferentially applied 3” (minimum) width tape of same material as the jacket, faced with the same adhesive as the longitudinal lap, or seal with Hardcast 4” wide Type DT490-C mineral impregnated woven fiber tape (synthetic fiber indoors, cotton fiber outdoors) using Hardcast FTA-20 activator/adhesive applied by brush or roller. Seal transverse joints at PVC fittings jackets with color matching PVC tape and vapor barrier mastic adhesive.
4. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of fiberglass pipe insulation, blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings.
5. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low-density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough-cut ends shall be coated with suitable weather or vapor resistant mastic as dictated by the system location and service.
6. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.

7. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems shall be sealed with caulking to allow free movement of the stem but provide a seal against moisture incursion.

8. Fit insulation terminations with Zeston, Snap Form, end cap jackets, or seal with Hardcast tape as specified above for joints.

9. On all piping (except equipment face piping) installed outdoors, install outdoor jacketing. Install aluminum sheet jacket with all joints turned down at 45° below horizontal; secure in place with non-corroding bands and/or blind rivets (do not puncture vapor barrier insulation jacket). On equipment face piping (including equipment shut-off valve) coat the insulation with 1/4" thick Foster 46-50 or Childers CP-10/11 (weatherproofing) mastic reinforced with glass fabric and finished with two (2) coats of aluminum paint.

10. Penetrations
   a. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.

I. Closed Cell Polyolefin:
   1. Install pre slit, pre-glued closed cell polyolefin foam pipe insulation as per manufacturer's recommendations. Seal all joints and seams with Fuse-Seal Gun or with Armstrong 520 adhesive or equal in accordance with manufacturer's written instructions. Fabricate fitting covers from polyolefin foam insulation using same procedure.

   2. Verify that work of this section may be installed in strict accordance with the original design, all pertinent codes and regulations, and all pertinent portions of the referenced standards.

   3. In the event of discrepancy, immediately notify the Architect.

   4. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

J. Install insulation in accordance with insulation manufacturer's instructions and as specified.

K. Install faced insulation with facing to occupied room side. Install non-rated facing in contact with unexposed surface of finish materials.

L. Do not install insulation over recessed light fixtures.

M. Trim insulation neatly to fit spaces. Fit insulation into crevices, spaces at outlet boxes and similar penetrations.

N. Maintain continuous foil faced vapor barrier. Provide fire resistive tape at all edges or penetrations of foil faced insulation, including batt ends.

O. Where wall insulation cavity exceeds 8 feet high, provide blocking or other approved support at 8 feet on center.

END OF SECTION
SECTION 22 08 00
COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS
   A. The General Conditions, Supplementary Conditions and Division 01 are fully applicable to this section, as if repeated herein.

1.2. RELATED WORK SPECIFIED ELSEWHERE
   A. Division 01, Section 01 91 13, General Commissioning Requirements
   B. All Division 22 Sections, and Division 23 and 25 Sections pertaining to BAS Controls for Plumbing Systems.

1.3. REFERENCES
   A. USGBC:
      1. LEED v4.0 Reference Guide for Building Design and Construction:
         a. Energy and Atmosphere Prerequisite: Fundamental Commissioning and Verification.
   B. California Energy Commission:
      1. Title 24, Part 6, 2016, Building Energy Efficiency Standards, Section 10-103 and Section 120.8-Building Commissioning
   C. ASHRAE:
      1. ASHRAE Guideline 0-2013: The Commissioning Process

1.4. DEFINITIONS
   A. Basis of Design (BOD): The documentation of design criteria and assumptions for systems, components, and methods chosen to meet the Owner’s Project Requirements and applicable regulatory requirements, standards, and guidelines. The document includes narrative descriptions of the systems to be commissioned. The BOD is prepared by the Design Professionals.
   B. Building Automation System (BAS): The automated building system providing control and user interaction with select building systems, such as the HVAC, domestic hot water and lighting systems. Also, often referred to as building management system (BMS), energy management system (EMS), or an energy management and control system (EMCS).
   C. Commissioning (Cx): A quality-focused process to verify and document that building systems are installed and perform as intended per the OPR, BOD and design documents.
   D. Commissioning Authority (CxA): An independent agent hired directly by the Owner and not otherwise associated with the Design Professionals or the General Contractor. The CxA is the authority on commissioning results and other commissioning program elements completion,
and assists the General Contractor with coordinating commissioning activities and witnesses the activities on behalf of the Owner.

E. Commissioning Issue: A condition that affects, prevents or inhibits commissioning, and must be resolved to complete the commissioning process.

F. Commissioning Issues & Recommendations Log (Cx Log): A log maintained by the CxA listing and describing all Cx issues and recommendations documented during the commissioning process, including providing the status, recommended action, contractor updates and resolution, and associated dates. All Cx issues require action, correction and closure.

G. Commissioning Report (Cx Report): The final report issued at the conclusion of the commissioning process. The report will include an executive summary abbreviating the outcome of the commissioning process and identifying all outstanding issues. The report also contains all commissioning documentation collected throughout all phases of the project.

H. Commissioning Plan (Cx Plan): A document that outlines the organization, coordination, and requirements of the commissioning process in more detail and contains project specific commissioning forms.

I. General Contractor (GC): The contractor directly contracted to the Owner with overall responsibility for the project and all commissioning activities described herein.

J. Commissioning Coordinator (CxC): Individual within the GC firm who plans, schedules, directs and coordinates all the Trade Subcontractor’s commissioning activities, and serves as the CxA’s single point of contact for all administrative, documentation and coordination functions.

K. Deferred Testing: Testing performed at a later time, due to partial occupancy, equipment, load, seasonal requirements, design or other site conditions that disallow the test from being performed prior to substantial completion.

L. Deficiency: A condition in the installation, function or performance of a component, equipment or system that is not in compliance with the contract documents and design. A deficiency will be considered a Cx issue and documented on the Cx Log.

M. Design Professional (DP): Architects, engineers and other consultants involved in the design of the project.

N. Functional Performance Test (FPT): A test of the dynamic function, operation and control of the equipment and systems to verify system performance to the fullest extent. Systems are tested under various operating modes and control sequences including failure modes. The FPTs are performed using manual (direct observation) or monitoring methods. The FPTs can include sequence of operation tests, performance tests, verification tests, integrated systems tests, and trend analysis.

O. HVAC&R: Heating, ventilation, air conditioning and refrigeration.

P. Installation Verification (IV): Field verification and documentation of proper installation of system equipment, assemblies and components, per design documents and manufacturer requirements. The IV process is typically complete when systems are ready for startup or operation. IV is organized and documented under the System Readiness Checklist (SRC) forms.
Q. Monitoring: The recording of parameters (temperature, flow, current, status, pressure, etc.) of equipment operation, which shall be completed using data-loggers or the trending capabilities of BAS or control systems.

R. Owner’s Project Requirements (OPR): A document describing the operational and functional requirements of a project, the expectations of how the facility will be used and operated, and the equipment and system expectations and requirements, as defined by the Owner. This document provides an explanation of the ideas, concepts, goals, success criteria, and supporting information for the project.

S. Percent Sampling: Witnessing the startup, checkout or testing of a selected fraction of the total number of identical or near-identical pieces of equipment or systems.

T. Pre-Functional Checks and Tests (PFCT): These are various checks and tests performed on a piece of equipment or system before, during, or after the initial startup and operation, but prior to the FPT phase. They are performed to confirm the system equipment and individual components were installed correctly and are working properly and meeting applicable performance requirements and specifications. They are all organized and documented under the SRC forms and are to be completed prior to FPTs.

U. Startup: Initial starting or activating of equipment usually performed by the Trade Subcontractor or the Manufacturer’s authorized representative.

V. Systems Manual: A manual that provides the operating staff the information needed to understand and optimally operate the commissioned systems. It expands upon the scope of traditional operating and maintenance documents and is compiled of multiple documents such as the final BOD, single line diagrams, and as-built controls drawings and sequences of operation.

W. System Readiness Checklist (SRC): A construction checklist, typically one or two pages, listing the necessary commissioning tasks and required documentation to verify a system is ready for FPTs, or system operation if no FPTs are performed. The tasks covered in the SRC include IV, Startup and PFCT, and the Trade Subcontractor completed forms for these tasks are attached to the specific SRC. The SRC must be completed and signed by the GC prior to conducting the FPTs.

X. TAB: Testing, Adjusting, and Balancing (TAB) work on the plumbing water systems to ensure design flow, pressure and temperature conditions are met. Performed by the TAB Trade Subcontractor.

Y. Trade Subcontractor: Typically a subcontractor to the GC who provides and installs specific building components and systems and/or provides certain services.

Z. Trending: Monitoring using the BAS or a control system, to aid in functional testing and to verify system operation and performance under actual operating conditions.

AA. Warranty Phase: The phase of the project immediately after the initiation of the building equipment warranty which spans the entire length of the project warranty.

1.5. DESCRIPTION OF WORK

A. Systems and equipment to be commissioned:
   1. Domestic cold and hot water systems and controls.
   2. Pumping systems and controls, including booster, sump, and sewage ejector pumps.
3. Plumbing fixtures with automatic controls.
5. Water recovery and re-use systems.
6. Any BAS controls or monitoring for plumbing systems.

B. Process equipment are not included in the commissioning scope of work.

C. The work includes the completion and documentation of formal commissioning procedures by the GC and Trade Subcontractors.
   1. The GC and Trade Subcontractors shall provide the quality control for the installation, startup, checkout and testing of the systems. The commissioning process provides independent review throughout the process and qualitative functional performance testing in order to formally observe and document the quality control efforts are completed.
   2. Refer to Section 01 91 13, General Commissioning Requirements for summary description of the general commissioning process and requirements.
   3. The Trade Subcontractors and the factory authorized service representatives shall be responsible for participation in the commissioning process as outlined in this specification and Section 01 91 13 General Commissioning Requirements.

1.6. COMMISSIONING PROCESS

A. Submittal Reviews by the CxA
   1. The CxA will review pertinent Trade Subcontractor submittals for the appropriate systems in the commissioning scope, concurrently with the Design Professionals and will provide review comments to the Design Professionals.
   2. The GC shall provide a submittal log to the CxA for referencing the requested submittals to be reviewed by the CxA (for which the GC shall issue to the CxA concurrently with the submission to the Design Professionals). Alternatively, the GC shall include the CxA on the distribution of all Trade Subcontractor submittals issued to the Design Professionals, for systems applicable to this specification.
   3. The GC shall issue the requested submittals to the CxA for review at the same time they issue the submittals to the Design Professionals.
   4. The CxA will also use the information from the submittals to develop commissioning forms and test procedures.

B. Cx Plan and Form Development
   1. The CxA prepares a Preliminary Cx Plan either during the project final design phase or early construction phase. The Cx Plan provides guidance in the execution of the commissioning process during construction and will contain the project specific commissioning forms.
   2. Commissioning during construction begins with a kickoff meeting conducted by the CxA where the CxA reviews the commissioning process and responsibilities with the appropriate team members. The CxA presents the Preliminary Cx Plan and discusses the project specific requirements.
   3. The CxA develops the SRC forms, which list the commissioning tasks and the associated IV, Startup, and PFCT documentation required for each system and equipment to be commissioned.
4. The CxA provides the SRC forms to the GC and Trade Subcontractors for review and comment.

5. The CxC shall submit to the CxA, for review and approval, the representative blank IV, Startup, and PFCT forms and plans for completing all IV, Startup, and PFCT tasks, prior to conducting any of these tasks.
   a. IV forms are to provide field verification and documentation of proper installation of system equipment, assemblies and components, typically completed prior to formal Startup. Where appropriate and approved by the CxA, these forms may be combined with the Startup or PFCT forms.
      1) The IV forms are a combination of Trade Subcontractor provided forms (which may include any applicable design drawings, floor plans, details, or single line diagrams that will be field verified) and the applicable equipment IV (pre-startup) checklists contained in the Manufacturer's installation manuals.
      2) The Trade Subcontractors are to verify equipment installation per the Manufacturer's guidelines and requirements, and thus are encouraged to use and complete any applicable equipment IV checklists contained in the Manufacturer's installation manuals, in addition to any IV forms used by the Trade Subcontractors to verify system installation per design.
   b. Startup forms consist of Manufacturer and/or Trade Subcontractor provided forms and plans used to document the completion of formal startup procedures and associated checks and verifications during the startup and initial operation. Where applicable, these forms shall include checks of the equipment internal / factory provided controls including sensors and control devices.
   c. PFCT forms and plans are Trade Subcontractor provided forms and plans used to document the completion and results for the various checks and tests performed before, during, or after startup.
   d. The CxA reviews the blank IV, Startup and PFCT forms and plans, and will issue any comments, which may include additions or changes to be made to the forms and plans, and/or supplemental forms may be issued by the CxA, where appropriate, to improve the forms and commissioning process.

6. The CxA will develop FPT procedures and forms, and provide the draft forms to the GC and Trade Subcontractors for review and comment.

7. The CxA will update and finalize the Cx Plan with equipment specific blank SRC, IV, PFCT and FPT forms.

C. System Readiness (Pre-Functional) Activities

1. Meetings will be conducted throughout construction with commissioning team members, as required, to plan, coordinate, and schedule commissioning activities, review documentation, and resolve Cx issues.

2. The Trade Subcontractors shall perform the IV, Startup and PFCT tasks for all systems and equipment (no sampling allowed), unless the contract or design documents allow for sampling of the pre-functional tests.
   a. In general, the GC and Trade Subcontractors should complete IV prior to Startup, but where appropriate and approved by the CxA, they can combine IV and Startup into one activity (and Startup is not performed if there are deficiencies identified from the IV).
3. The Trade Subcontractors and the CxC shall document completion of the IV, Startup and PFCT tasks on the IV, Startup, PFCT and SRC forms, and shall complete the SRC forms and attach the completed IV, Startup, and PFCT forms to the SRCs forms.
   a. The intent of the SRC forms is for the GC and Trade Subcontractors to certify that the plumbing systems, controls and instrumentation, equipment and assemblies have been installed, started, calibrated and are operating per the contract and design documents.

4. The CxA will review the completed IV, Startup, PFCT and SRC forms. The CxA will also perform various field observations and reviews, and witness a sample of the Startup and PFCT activities (some PFCT witnessing may be performed as back-checks after PFCT tasks are completed).
   a. The Trade Subcontractor shall resolve any IV and PFCT results deemed unacceptable by the CxA. And the Trade Subcontractor shall execute a new sample of the PFCT to be witnessed by the CxA. The CxA shall deem the PFCT acceptable after resolution of all issues and any witnessed sampling results in no issues.

5. The CxC shall submit all completed SRC forms to the CxA for review prior to conducting the FPTs. The CxA shall deem the SRCs acceptable after all SRC forms and supporting IV, Startup and PFCT forms are complete and any issues have been addressed.

D. Functional Performance Testing

1. FPTs are to test the dynamic function, performance and control of the equipment and systems under various modes of operation. These tests verify the correct implementation of the sequences of operation and the system performance meets the design criteria. The FPTs are performed using manual (direct observation) or monitoring methods. FPTs include the following types of tests, where applicable:
   a. Sequence of Operation Tests.
      1) Sequence of operation tests are witnessed by the CxA for each unique sequence of operation but may not necessarily be repeated across identical systems, equipment or spaces, if the contractor has verified the same programmed sequence of operation code (as tested) has been programmed across multiple identical systems, equipment or spaces, based sample verification tests witnessed by the CxA (see below).
   b. Verification Tests.
      1) Verification tests are often less detailed tests than the sequence of operation tests and are typically witnessed by the CxA at a higher sample rate. Examples of verification tests include:
         a) verifying the programmed sequence of operation code is the same as the as-tested code per the sequence of operation tests,
         b) verifying the alarm points are configured per the sequence of operation tests (without having to repeat the actual sequence tests),
         c) reviewing and confirming control point displays on system graphics and required setpoints (for example verifying the BAS VAV min, max cool, max heat airflow setpoints are correct per design),
         d) testing certain critical or important sequences with a higher sample rate across identical systems, equipment or spaces, beyond the individual sequence of operation tests.
   c. Performance Tests.
1) Performance tests are to be performed after the sequence of operation and verifications tests, and are focused on testing and verifying performance. Performance tests are typically witnessed by the CxA at a lower sample rate. Examples include:

a) testing and measuring fixture hot water temperature and delivery time per design criteria,

b) testing the DHW heater water flow and temperature performance at simulated high cooling load conditions per design.

d. Integrated Systems Tests.

1) Integrated systems tests verify the operation and performance of multiple systems together operating in a coordinated, stable and efficient manner. Often the integrated systems tests are combined with the performance tests.

e. Trend Analysis.

2. The CxA will develop FPT forms that contain:

a. Specific step-by-step procedures to execute the test in a clear, sequential and repeatable format, including any control system point value or setpoint overrides required to simulate a test condition or sequence mode.

b. The expected system response and acceptance criteria of proper performance with a Yes/No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.

c. A section for recording actual system response, notes and comments.

3. Once the SRC forms are complete, the Trade Subcontractors shall execute the FPTs, with the FPTs witnessed by the CxA.

a. The GC and Trade Subcontractors are responsible for ensuring all systems are installed, operating and performing per the requirements of the contract and design documents, and are ready for the FPTs.

b. The Trade Subcontractors shall determine what level of pre-testing is appropriate in order to prepare for the CxA witnessed FPTs.

c. The CxA recommends the Trade Sub-Contractors complete the Title 24 acceptance testing and forms (see paragraph f below) as part of the contractor's pre-testing and readiness for the CxA witnessed FPTs.

d. A percent sampling approach shall be used for executing the FPTs of identical systems and equipment. The approximate system sampling rates for the manual (direct observation) FPTs are defined in Part 3 of this specification and/or in the Cx Plan.

e. The acceptance criteria for the FPT sampling shall be zero, meaning, any FPTs that do not pass shall require the Trade Subcontractor to resolve the issue for all applicable systems and equipment (even those specifically not in the original sample) and new sample rates selected for a re-test executed by the Trade Subcontractor and witnessed by the CxA. The CxA shall deem the FPTs acceptable after all FPTs, including re-tests, have passed and resolution of all issues completed.

f. The CxA will document the results of all FPTs on the associated FPT forms created by the CxA, unless indicated otherwise on the FPTs, and excluding completion of the Title 24 Certificate of Acceptance forms.
1) Completion of the Title 24 Certificate of Acceptance forms (contained in Appendix A of the Title 24, Part 6 Compliance Manual) is a contractor responsibility, not the CxA responsibility.

2) The responsible Division 22, 23, 25 and 26 Trade Subcontractors are also responsible for providing qualified and certified "Field Technicians" (per Title 24, Part 6 requirements) to perform and document the results of the acceptance tests on the applicable Title 24, Part 6 Certificate of Acceptance forms.

4. The Cx Plan will define any required seasonal or deferred testing.

E. Cx Issues and Recommendations

1. Throughout the process, the CxA records Cx issues and recommendations on the Cx Log and distributes the Cx List to the team. The GC and Trade Subcontractors shall correct Cx issues and recheck or retest the system(s) without delay at no additional cost to the Owner. The CxA will verify the completion of the issues and recommendations, and make all amendments to the Cx Log.

F. Training Verification and Final Documentation

1. The GC shall submit a comprehensive Training Plan (with specific training agendas provided by the Trade Subcontractors) for review by the Design Professionals, CxA and Owner, prior to conducting any training. The Training Plan shall meet the specific requirements in the contract documents and specifications for each applicable system to be commissioned and the LEED Enhanced Commissioning requirements, and may include both operations and maintenance (O&M) staff training and building occupant training. The GC shall coordinate with the Owner and/or Owner's Representatives, as needed, regarding any specific requirements for occupant training.

2. The CxA will verify completion of the training by witnessing some training sessions and receiving a copy of all training class sign-in sheets and any training materials / handouts, to be provided by the CxC or Trade Subcontractors.

3. The CxA will develop the Systems Manual (per the LEED requirements), including the current facility requirements, a preventative information and an ongoing Cx plan, with assistance from the GC and Trade Subcontractors.

4. The CxA will complete the Commissioning Report and all associated documentation for the Owner with assistance from the GC and Trade Subcontractors.

G. Post-Occupancy Warranty Phase Commissioning

1. The CxA will report any identified operational or performance issues (identified by the building O&M staff or warranty phase Cx activities) to the CxC via a Warranty Phase Cx Log for resolution by the GC and Trade Subcontractors during or prior to the end of the warranty period.

2. The Trade Subcontractors shall execute any defined seasonal or deferred FPTs, witnessed by the CxA.

3. The CxA may and analyze review trend data during the Warranty Phase and will report any identified issues and recommendations for system improvements from the trend analysis.

4. No later than either 10 months after substation completion or two months prior to the expiration of the first 12-month warranty period of building occupancy, the CxA will return to the facility to interview facility O&M staff, walk the facility and review systems operation
and trend data where applicable. Key representatives from the GC and Trade Subcontractors shall attend a site walk-through and meeting, as determined by the CxA.

1.7. COMMISSIONING TEAM

A. The Commissioning Team is responsible for performing the process and achieving successful commissioning results. The Commissioning Team is comprised of the following:

1. Owner and Owner’s Representatives
2. Commissioning Authority (CxA).
3. Design Professionals
4. General Contractor (GC)
5. GC’s Commissioning Coordinator (CxC)
6. Trade Subcontractors responsible for systems covered in this section include:
   a. Plumbing Contractor
   b. BAS Controls Contractor (if applicable)
   c. TAB Contractor (if applicable)
   d. Water Recovery & Re-use System Specialist or Manufacturer’s Representative (if applicable)
7. Manufacturer Representatives supplying equipment, materials, components and controls for the systems to be commissioned.

1.8. RESPONSIBILITIES

A. General.

1. The Commissioning Team and all others involved in the commissioning process shall follow the Commissioning Plan, attend the commissioning kickoff meeting, and attend additional commissioning meetings as necessary.

B. Commissioning Authority (CxA)

1. See Section 01 91 13, General Commissioning Requirements.

C. General Contractor:

1. See Section 01 91 13, General Commissioning Requirements.

D. Trade Subcontractors – General Requirements:

1. Provide and submit for CxA review, the representative blank forms and plans for completing all IV, Startup, and PFCT tasks, including manufacturer’s installation checks and startup procedures. Electronic files are acceptable.

2. Provide any equipment and construction submittals and shop drawings, including detailed sequences of operation, and any other requested contract documentation for systems to be commissioned, as requested by the CxA. Electronic files are acceptable.

3. Attend commissioning meetings as directed by the CxA and GC’s CxC to facilitate the commissioning process.

4. Assign personnel with expertise and authority to act on behalf of the Trade Subcontractor and schedule them to participate in and perform assigned commissioning tasks.
5. Ensure that any required manufacturer factory tests are performed and provide the factory test data and results where required.

   a. Perform IV, Startup and PFCT tasks for all systems and equipment (no sampling), unless the contract or design documents allow for sampling of these tasks.
   b. Complete all IV, Startup and PFCT documentation clearly and legibly.
   c. Submit all completed IV, Startup and PFCT forms to the CxC and CxA, as part of completing the SRC forms, for review by the CxA.

7. Provide a schedule and access for the CxA to witness any equipment Startup and PFCT tasks. Notify the CxC and CxA at least 10 days in advance of Startup and PFCT tasks.

8. Ensure that any required manufacturer’s representative field tests and on-site IV, startup and checkout of selected equipment are performed per the contract documents. Provide completed manufacturer documentation and commissioning forms for these activities to the CxC.

9. Address applicable Cx issues promptly. All IV, Startup and PFCT issues must be resolved before the FPTs can proceed.

10. Assist the CxA in preparing the FPT procedures, clarifying the operation and control of commissioned equipment where the specifications, control drawings or equipment documentation are not sufficient for writing detailed testing procedures.

11. Review the FPT procedures to ensure feasibility, safety and equipment protection, and provide necessary written alarm limits, setpoint changes and overrides to be used during the tests.

12. Setup any additional control system software points, global commands, overrides of any sensor values or relays, and overrides of any setpoints or schedules, to simulate certain conditions and operating modes, in order to conduct the FPTs.

13. Perform the FPTs, with the FPTs witnessed by the CxA. Provide at least 10 days advance notice to the CxC and CxA for scheduling the FPTs.

14. The Division 22, 23 and 25 Trade Subcontractors (Plumbing, Mechanical and BAS) are responsible for providing qualified and certified "Field Technicians" (per Title 24, Part 6 requirements, where applicable) to perform and document the results of the acceptance procedures (Acceptance Tests) on Certificate of Acceptance forms per Title 24, Part 6.
   a. The GC or the responsible Trade Subcontractor shall be the designated "Responsible Person" per Title 24, Part 6, for certification of the acceptance testing/verification on the Certificate of Acceptance forms (contained in Appendix A of the Title 24, Part 6 Compliance Manual).

15. Setup the BAS and any other control system trends and provide all requested Trend data for the FPTs and post-occupancy warranty phase commissioning review to the CxA.
   a. As an Owner approved alternative, the Trade Subcontractors may provide the CxA remote access to the BAS and any other control system, with the Owner’s permission, which will allow the CxA to easily and directly download the trend data files.

16. Prepare a training agenda for each training class for the equipment and systems to be commissioned.

17. Coordinate with the GC and Owner to schedule and plan training. Execute training of Owner’s personnel per approved training agenda and schedule. Provide copies of training class sign-in sheets and materials / handouts.
18. Prepare O&M Manuals according to the Contract Documents.

19. Assist the CxA in developing the Systems Manual, including providing as-built drawings, controls sequences, setpoints, single-line diagrams, etc., necessary for the Systems Manual.

E. Trade Subcontractors – Specific Plumbing System Requirements

1. In addition to the general Trade Subcontractor responsibilities outlined above, the Plumbing Trade Subcontractor responsibilities during commissioning shall include, but are not limited to:

   a. Provide approved submittals, including shop drawings, control drawings (showing all control points and sensors), points list and detailed sequences of operation for each piece of equipment and system to be controlled (inclusive of any local, stand-alone plumbing system controls). The control system diagrams shall show all control points, sensor locations, actuators, and controllers. The system sequence of operation shall fully describe their equipment components and functionality, including setpoints, failure modes and alarm functions. The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings. Electronic files are acceptable.

   b. Provide a list of any test metering and sensors to be used for sensor and device calibration purposes. All test meter and sensors shall have been calibrated within a year and have calibration documentation.

   c. Submit a Pipe System Pressure Test Plan for all applicable plumbing systems (including water recovery and re-use), for review by the CxA, at least 4 weeks in advance of conducting any required tests. The Test Plan shall include the section of pipe to be tested, and the test methods, pressures and durations.

   d. Submit a Clean, Flush and Treatment Plan for all applicable plumbing systems (including water recovery and re-use), for review by the CxA, at least 4 weeks in advance of filling any plumbing hydronic systems. The Plan shall include the following:

      1) The intended minimum durations for all pipe cleaning and flushing, the associated disinfectants to be used and any applicable water treatment to be performed after the clean and flush.

   e. For any applicable, dedicated Plumbing and Water Recovery / Re-use Control Systems (not part of the BAS or not plumbing equipment factory controls), submit representative blank forms for conducting any Controls IV and PFCT tasks to be conducted by the Trade Subcontractors, for review by the CxA, at least 4 weeks in advance of performing any Controls IV and PFCT tasks. The dedicated plumbing Control Systems IV and PFCT tasks forms shall include:

      1) Installation verification checks of the control input and output points (sensors, actuators, relays, etc.) to verify all points have been installed per the points list and the physical installation of each point has been verified.

      2) Point-to-point checks with the local controller display interface or graphics.

      3) Sensor accuracy checks or calibration results:

         a) For analog input sensors that are factory calibrated (no field calibration is required per Specifications):

            i. The controller or control system program setup (point type, range/scale, etc.) shall be verified and recorded in the PFCT forms, and the sensor
reading on the local controller display or graphics shall be recorded on the PFCT forms and shall be checked by verifying the sensor reading is within the expected range.

ii. Sensor readings that are questionable or outside the expected range shall be checked using a hand-held sensor of equal accuracy.

b) For sensors that require field calibration, follow the manufacturer requirements for calibration and record the calibration results in the PFCT forms, including any readings using a hand-held sensor of equal accuracy.

4) Actuator checks:

a) At a minimum, all actuators shall be physically checked at commanded full open position (100% open), commanded half-open position (50% open) and commanded fully closed position (0% open).

f. For the BAS Controls IV and PFCT blank forms applicable to the plumbing systems, see Section 23 08 00.

g. For local plumbing equipment factory provided controls, the controls IV and PFCT forms can be included in the equipment specific IV and Startup forms (for example, as part of the plumbing contractor’s or manufacturer representative’s IV and Startup forms for the specific equipment inclusive of all local controls).

h. Submit the applicable completed dedicated plumbing Control System IV and PFCT forms for review by the CxA. After submitting the completed forms, the CxA may request onsite field review and back-check of the Controls IV and PFCTs, for an approximate 10% to 20% sample, to be selected by the CxA, or what can be accomplished in 1 full day.

i. Submit representative blank Plumbing Fixture Controls IV and PFCT forms, for review by the CxA, at least 4 weeks in advance of performing any IV.

1) The forms shall either contain floor plan based checklists or room by room table checklists that indicate completion of the IV and PFCT tasks for each plumbing fixture with automatic controls.

2) The intent of the forms is to:
   a) verify the installation of each fixture per design documents and manufacturer requirements,
   b) to verify any applicable automatic control settings have been adjusted and checked,
   c) and to verify the operation and control has been tested.

3) The completed forms shall be attached to the corresponding SRC form.

j. Submit the completed Plumbing Fixture Controls IV and PFCT forms for review by the CxA. After submitting the completed forms, the CxA may request onsite field review and back-check, for an approximate 10% to 20% sample, to be selected by the CxA, or what can be accomplished in 1 full day.

k. Submit a Plumbing Water and Gas Meter IV and PFCT Plan with blank forms, for review by the CxA, at least 4 weeks in advance of conducting any IV. The Plan shall include the following items:

1) An outline of the plumbing meter IV per design and manufacturer requirements.

2) An outline of any plumbing meter pre-functional tests, required per specifications.
3) An outline of any plumbing meter pre-functional checks (e.g., meter programming checks, meter alarm configurations, etc.).

4) The representative blank IV and PFCT forms to be used.

i. Submit the completed Plumbing Meter IV and PFCT forms for review by the CxA. After submitting the completed forms, the CxA may request an onsite field review and back-check prior to conducting any FPTs.

m. Submit Plans for all other applicable plumbing systems pre-functional testing, per the project specifications, for review at least 4 weeks in advance of any required tests.

n. The Trade Subcontractors shall configure all plumbing system local equipment controls settings and/or control system settings, graphics and programming logic for the sequence of operations and associated setpoints, schedules, and alarms and verify the system operation, including the control loop tuning, prior to starting FPTs.

o. Prior to conducting the CxA witnessed FPTs, place the systems and controls into the operating modes intended for testing. Check all control system safety cutouts, alarms, and interlocks with other systems during each mode of operation prior to functional testing. Ensure all systems are operating and performing per the requirements of the contract and design documents, and have been pre-tested per the FPTs, and are ready for the CxA witnessed FPTs.

1) The Trade Subcontractors shall determine the appropriate level of pre-testing, to prepare for the CxA witnessed FPTs.

p. Participate in any applicable integrated whole building tests under emergency power. This test is initiated by disconnecting the utility power to the building, and it will involve multiple disciplines. All Trade Subcontractors shall participate in the FPTs as required for operation of the inter-related systems.

F. Trade Subcontractors – Specific BAS Control Requirements

1. See Section 23 08 00 for the additional specific BAS Trade Subcontractor responsibilities, applicable for any BAS controls and monitoring for plumbing systems.

G. Trade Subcontractors – Specific TAB Requirements

1. See Section 23 08 00 for the additional specific TAB Trade Subcontractor responsibilities, applicable for any TAB work for plumbing systems.

1.9. SUBMITTAL REQUIREMENTS FOR COMMISSIONING

A. Trade Subcontractor Commissioning Forms. The Trade Subcontractors shall submit to the CxA all applicable representative, blank forms and plans for IV, Startup and PFCT tasks for the project (as listed in 1.8 Trade Subcontractor Responsibilities), at least 4 weeks in advance of performing any of these tasks.

1. The draft SRC forms issued by the CxA will list the required IV, Startup and PFCT forms and plans, required for this project. The Trade Subcontractor shall review the draft SRCs to ensure all applicable, representative IV, Startup and PFCT forms and plans have been submitted for the CxA review.

2. The CxA will review these submitted commissioning forms including whether all project specific requirements are included.

3. The CxA may request additional data, changes and/or additions to these forms to confirm application prior to their use. If the Trade Subcontractor cannot submit sufficient forms, the CxA will provide forms based on the construction documents and specifications,
manufacturer installation manuals and procedures, and/or industry standards or guidelines.

B. Training Agenda. The Trade Subcontractors shall develop a Training Agenda for each training session, per the requirements of the contract documents and specifications, and the LEED Enhanced Commissioning requirements, and may include both operations and maintenance (O&M) staff training and occupant training. The Training Agenda shall be included in the comprehensive Training Plan to be submitted by the GC for review by the CxA, Design Professionals, and/or the Owner (see Section 01 91 13). The GC and Trade Subcontractors shall coordinate to fully develop the comprehensive Training Plan with input from the Owner.

1. The Training Agenda for each training session shall include the following:
   a. equipment and/or systems covered;
   b. recommended attendees;
   c. proposed location;
   d. estimated duration;
   e. level of instruction to be provided and an outline of the training topics and subjects to be covered;
   f. list of any materials and handouts to be provided (or provided in advance);
   g. company to provide the training and the instructor's name and qualifications.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1. MEETINGS, SCHEDULING AND COORDINATION

   A. See Section 01 91 13.

3.2. DOCUMENTATION

   A. The Trade Subcontractors have specific responsibilities for assisting in the development of equipment check, test and verification procedures and forms, and in performing and documenting commissioning tests, as directed by the CxC and as overseen by the CxA.

   B. The Trade Subcontractors shall provide, wherever the Contract Documents require, system checks and testing, test reports, factory test data and reports, checklists, operational verifications and demonstration, etc., whether specified or not in the commissioning sections.

3.3. TEST EQUIPMENT

   A. The Trade Subcontractor shall provide all test equipment in sufficient quantities to execute all Pre-Functional and Functional Performance Tests in an expedient fashion.

   B. The test equipment shall be of industrial quality and suitable for testing and calibration with accuracy within the tolerance necessary to demonstrate system performance per the Contract Documents. If not otherwise specified, the following minimum requirements apply:

   1. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 degree F and a resolution to + or − 0.1 degree F.
2. Pressure sensors shall have an accuracy of + or - 2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year.

3. Meters for measuring total dissolved solids (TDS) via electrical conductivity shall have an accuracy of + or - 2.0 percent and have been calibrated within the last year. Offsite lab testing of Water Recovery and Reuse System TDS levels is not required for testing and verification of installed TDS meters / sensors.

C. The test equipment shall have calibration certification per equipment manufacturer's interval level or within one year if not otherwise specified. The calibration tags shall be affixed or certificates readily available for all test equipment.

3.4. SYSTEM READINESS: INSTALLATION VERIFICATION, STARTUP, PRE-FUNCTIONAL CHECKS & TESTS

A. The Trade Subcontractors shall conduct all startup procedures and tests without compromise to human or equipment safety. The GC and Trade Subcontractors shall be responsible for the liability and safety of conducting all startup, checks and tests.

B. The Trade Subcontractors shall clearly identify and list any issues and deficiencies resulting from the IV, Startup and PFCT tasks on the associated forms and immediately notify the CxA. The CxA will additionally document the issues on the Cx Log. Once issues and deficiencies are corrected and verified, the associated forms shall be updated and resubmitted, and any necessary field review, back-checks or re-tests witnessed by the CxA.

C. The CxC and Trade Subcontractors shall provide a minimum 10 days’ notice to the CxA for witnessing equipment Startup and PFCT tasks.

1. The sample rates for the CxA witnessing of plumbing system piping PFCT tasks and equipment startups, will be defined in the Cx Plan.

D. The GC and Trade Subcontractors shall ensure the completion of the SRC forms. Review and approval of the completed SRC forms by the CxA is required prior to conducting the FPTs.

3.5. FUNCTIONAL PERFORMANCE TESTS

A. The Trade Subcontractors shall perform all FPTs per the final FPT forms and complete the Title 24 Part 6 acceptance test requirements and Certificate of Acceptance forms, for all systems and equipment in the scope of commissioning. The FPTs shall be witnessed by the CxA. The Trade Subcontractors may need to complete off hours or weekend work in order to complete the FPTs.

B. The CxA will document all testing results on the FPT forms, not including the Title 24 Certificate of Acceptance forms. The completion of the Title 24 Certificate of Acceptance forms is a contractor responsibility.

C. As outlined in the Part 1 general commissioning process, a sampling approach shall be used for the FPTs of identical systems and equipment, using the sample rates as defined in the Cx Plan, with the specific systems and equipment selected by the CxA.

D. The Trade Subcontractors shall determine what level of pre-testing is appropriate in order to prepare for the CxA witnessed FPTs.

E. The CxC and Trade Subcontractors shall coordinate all FPTs with the CxA, and provide a minimum of 10 days' notice prior to conducting each test.
F. The GC and Trade Subcontractors shall have responsibility for the liability and safety of conducting all functional performance tests.

G. The Trade Subcontractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. to execute the test according to the test procedures.
   1. The Trade Subcontractors shall provide any necessary control system global or system level commands and setpoint adjustments necessary to conduct the testing as called out in the FPT procedures.

H. At completion of the test, the Trade Subcontractor shall return all affected building equipment and systems to their pre-test normal condition.

3.6. COMMISSIONING ISSUES, BACK-CHECKS AND RE-TESTS

A. When Cx issues are identified during testing, the CxA will discuss with the executing Trade Subcontractor and/or CxC and determine whether or not testing can proceed. The CxA may allow immediate correction of minor issues and deficiencies identified during testing. The Cx issue and any identified resolution will be documented on the test form in use in addition to the Cx Log.

B. The CxA will maintain and update the Cx Log, and document the issue resolution process. Copies will be distributed to the GC, Owner, and Trade Subcontractors as appropriate. The Trade Subcontractors shall provide updates and comments regarding issue status and resolution.

C. The Trade Subcontractors shall promptly correct all Cx issues. The responsible party shall correct the issue and inform the CxC and CxA of the resolution and completion date, and update the Cx Log accordingly (in the fields assigned for contractor updates).

D. The CxA will record completion on the Cx Log after a successful witnessed re-test, field review, back-check, verification obtained through appropriate documentation or photographs, or acceptance by the Design Professional or Owner. The CxC shall reschedule any applicable re-testing with the CxA and Trade Subcontractor. The Trade Subcontractor shall retest until achievement of passing performance or Owner acceptance of the noted issue.
   1. Where sampling is used for the PFCTs and FPTs, the results shall be deemed acceptable once all noted issues are resolved and any new sample tests or checks have passed.

E. Additional parties may require input during a dispute regarding a Cx issue. Regardless of the validity or responsibility of the issue, the CxA will have the final interpretive authority on Cx issues and the Owner will have the final approval authority.

F. The CxA may recommend solutions to Cx issues. However, the GC and Trade Subcontractors ultimately have the burden of responsibility to solve, correct and perform required retests.

G. Back-checks, Verifications and Re-testing:
   1. The CxA will witness one (1) re-test or will perform one (1) field back-check or verification of any Cx issue.
   2. The CxA’s total onsite time for re-test witnessing and field verification or back-check of Cx issues will be limited to no more than 2 work days (full 8-hour work days) for all applicable systems in the commissioning scope.
3. The Owner may back-charge the GC for any additional fees from the CxA, resulting from any additional re-testing or field back-checks or verifications beyond this allocated total time.

4. The CxC must provide a minimum 48 hours’ notice for scheduling any re-testing, though the CxA will attempt to accommodate a shorter timeframe if feasible.

5. Any required re-testing shall not be considered a justified reason for a claim of delay or for a time extension.

H. For any re-testing required, the CxA will determine if the entire test must be re-tested or if it is acceptable to re-test specific portions of the test that had failed.

3.7. DEFERRED & SEASONAL TESTING

A. Before or during the end of the first year warranty period, the Trade Subcontractor shall complete any seasonal or deferred testing, required per the design specifications and as defined in the Cx Plan. The Trade Subcontractors shall complete tests in the same manner as all other commissioning tests, including CxA witnessing.

B. The CxC and Trade Subcontractor shall coordinate with CxA and Owner and schedule all deferred and seasonal testing.

3.8. TRAINING VERIFICATION

A. The CxC and Trade Subcontractors shall coordinate and schedule the training for the Owner’s facility and operations personnel, and building occupants. The CxC shall ensure that training is completed per the requirements of the contract documents and specifications.

B. Trade Subcontractors responsible for specific equipment and system training shall submit to the CxC, a written training agenda for each training class for the equipment and systems to be commissioned. The GC shall submit a comprehensive Training Plan, including the specific training agendas, to Owner, Design Professionals and CxA for review and approval. See also Section 01 91 13.

C. The CxA will review the Training Plans for commissioning verification prior to conducting the actual training.

D. For verification of actual training conducted, the CxC shall submit to CxA ‘attendee signed’ attendance sheets for each training session conducted and a copy of any final training presentations or handout materials.

3.9. COMMISSIONING ACCEPTANCE, CLOSE-OUT AND REPORTING

A. Completion of the main commissioning activities (system readiness checks, functional performance testing, and training) shall be accomplished as a prerequisite for substantial completion. Completion of any re-testing shall be completed prior to final acceptance of commissioning.

B. After completion of the main commissioning activities and following review of the completed commissioning documents, test results and the current Cx Log with the Owner, the Owner will indicate whether they accept completion of the project construction phase commissioning or if not, the requirements for acceptance. Upon Owner acceptance, any remaining open Cx issues will be transferred to the warranty phase Cx Log for tracking resolution and completion as part of the warranty phase commissioning.
C. Upon completion of all commissioning activities, the CxA will prepare and submit to the Owner a Cx Report detailing all completed commissioning activities and documentation. The CxC shall support this effort by providing all GC and Trade Subcontractor commissioning documentation.

D. The CxA will complete a Systems Manual for the systems and equipment commissioned, following the LEED requirements, with assistance provided by the CxC and Trade Subcontractors. The Systems Manual will provide the operating staff the information needed to understand and optimally operate the commissioned systems. It will also include the current facility requirements, O&M preventative maintenance information, and an ongoing commissioning plan. Per LEED enhanced commissioning requirements, the Systems Manual will contain the following sections and detail:

1. Current facility requirements including the final version of the BOD and systems narrative.
2. Final equipment list.
3. Systems single line diagrams or schematics.
4. Final as-built sequence of operations, control drawings (P&IDs), points lists and setpoints.
5. Additional operating instructions for key systems or integrated building systems such as water-side and air-side HVAC systems and controls, plumbing systems, lighting controls, etc.
6. Recommended schedule of major preventative maintenance requirements and frequency.
7. Ongoing Cx Plan
   a. Definition of the ongoing commissioning process, defined roles and responsibilities, a recommended schedule for recommissioning the systems;
   b. Recommended schedule for retesting of commissioned systems with blank test forms from the Final Commissioning Plan.
   c. Recommended schedule for calibrating sensors and actuators.

3.10. POST-OCCUPANCY WARRANTY PHASE COMMISSIONING

A. The Trade Subcontractors shall execute any defined seasonal or deferred FPTs, witnessed by the CxA.

B. The CxA may review BAS trend data during the Warranty Phase. The BAS Trade Contractor shall be responsible for providing post-occupancy trend data to the CxA.

C. The CxA will report any identified issues and recommendations to the CxC via a Warranty Phase Cx Log for review and resolution by the GC and Trade Subcontractors prior to the end of the warranty period, for any issues or recommendations identified either by the CxA or the Owner. The CxC shall work with the Trade Subcontractors and O&M staff to make corrections and adjustments as required to address the issues and recommendations.

D. Key representatives from the GC and Trade Subcontractors shall attend a near end of warranty commissioning review meeting, to be scheduled with the Owner’s facility staff and the CxA, no later than either 10 months after substation completion or two months prior to the expiration of the first 12-month warranty period of building occupancy.

1. During this meeting, the operation of the systems will be discussed with the Owner’s staff, the results of any commissioning trend analysis will be reviewed and the warranty phase Cx Log will be reviewed. If needed, a walk-through of the systems with the Owner’s staff will be conducted.
2. Next steps and actions items for any open Cx issues and recommendations will be discussed and documented via meeting minutes or a field report issued by the CxA. The intent is to resolve any open Cx issues prior to the end of the warranty phase.

E. After correcting noted Warranty Phase Cx issues, the CxC shall notify the CxA, and the CxA will back-check and verify resolution of the Cx issues and recommendations.

F. Issues identified during the warranty period will remain warranty phase Cx issues until satisfactory completion by Trade Subcontractors, even if the warranty period expires during the correction and back-check period.

END OF SECTION
SECTION 22 11 00
FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Section 22 05 00 applies to this section.

1.2 SUMMARY
   A. This section includes all plumbing (equipment, fixtures, pipe and fittings, specialties) inside the building(s) and outside the building(s) to the point of connection to site plumbing systems.
   B. Provide complete plumbing systems including:
      1. Service connections to existing on-site utilities, and stubs for future connection to equipment provided under the work of this Section or other Sections of the Specifications.
      2. All piping systems for conduction of cold water and heated water as shown or specified for plumbing work.
      3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings, piping, and other piping accessories as shown or specified for plumbing work.
      4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.

1.3 RELATED SECTIONS
   A. Section 22 05 00 – Plumbing
   B. Section 22 07 00 - Insulation
   C. Section 21 00 00 - Fire Protection
   D. Section 23 00 00 - Heating, Ventilating, & Air Conditioning

1.4 STRUCTURAL REQUIREMENTS
   A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer and approval from DSA. Where possible, offset vents and pipes rising in walls, concealed above ceilings, below plates and rise through roof. Where this is not possible, install vents and pipes through plates as detailed on structural drawings.

1.5 SUBMITTALS
   A. Submit a general statement of materials and methods along with manufacturer’s technical data and installation instructions for all equipment, fixtures, pipe and fittings, and plumbing specialties to be installed.
   B. Record Drawings: Per specification section 22 05 00 requirements.
      1. Operation and Maintenance Manuals: Per specification section 22 01 00 requirements.
PART 2 - PRODUCTS

2.1 GENERAL
A. Adapters: Wrought copper male adapters shall be used wherever it is necessary to connect copper tubing to a valve or "tee" having threaded connections.

2.2 PIPE PROTECTION
A. Bare copper pipe buried in the ground shall have a corrosion protective wrap of one of the following:
   1. Polyvinyl Chloride Tape: The tape shall be of a minimum thickness of 10 mils and shall be laminated with a suitable adhesive, or shall be applied with a suitable primer adhesive. Width as recommended by the manufacturer for the pipe sizes being wrapped (4" minimum). Tape shall have continuous identification.
   2. 3M X-Tru-Coat, factory-applied plastic coating with additional field-applied double-layer wrapping of Scotchrap #51, 20-mil plastic tape, Trentex No. V-10, B-20, Scotchwrap No. 50 Polyvinyl chloride tape wrap, or thermofit sleeves.
   3. Field Joint Cover: Tape coat, prime coat and one layer of Tape coat #20 heat-applied 62-mil tape.

PART 3 - EXECUTION

3.1 MINIMUM COVER
A. Provide trenching and backfill for buried piping and install at the following depth unless shown otherwise, cover is from top of pipe to finish grade.
B. Water - 30"

3.2 INSTALLATION OF PIPING SYSTEMS
A. General:
   1. Install exposed polished or enameled connections from fixtures or equipment with special care, showing no tool marks or threads at fittings. Inspect each piece of pipe and each fitting carefully for defective workmanship on pipe, or obstruction in pipes and fittings.
   2. Anchor pipe subject to expansion or contraction in a manner permitting strains to be evenly distributed and alleviated by swing joints or expansion loops which shall be installed as required and/or shown. Underground anchors shall consist of plates welded to pipe and encased in concrete. Anchor all domestic cold water piping at all toilet areas that have flush valve urinals or toilets.
B. Thrust Blocks: Provide concrete anchors or thrust blocks for all non-metallic water mains in the ground. Install at all changes in direction and at branch take-offs 2" and larger. Form Thrust Blocks by pouring concrete between the pipes and trench wall. They shall be adequate in size and placed to take all thrusts created by the maximum internal water pressure, as recommended by manufacturer.
C. Sleeves: Install sleeves of sufficient size to allow for free motion of pipe. Finish sleeves flush when in walls and extend a minimum of 2" above floor when passing through floor slabs and outside walls shall be caulked with oakum and mastic and made watertight. No visible leakage at sleeves will be permitted. Sleeves may be omitted for waste lines through
slabs on grade and rising into a concealed space if wrapped with 1" insulation. Sleeve all pipes where pipes pass through footings with PVC pipe sleeves.

D. Fire-Barrier Penetrations: Seal pipe penetrations with fire-stopping sealant material.

E. Cathodic Protection: Install insulated flanges or dielectric unions at points of connection between pipes and equipment as follows: (1) between copper or brass piping and steel or cast iron pipe. (2) Between copper or brass piping and any steel material. (3) Buried connections of copper or brass piping to steel or cast iron piping shall be protected with a polyvinyl tape wrap 10 mils thick, extending 5' each way from connection.

F. Expansion: Install piping with sufficient offsets, loops, and/or swing joints to allow for expansion and contraction. Anchor piping at equipment to restrain movement at those locations.

G. Freeze Protection: Piping shall not be installed in a location subject to freezing conditions. All piping shall and must be installed on the "warm" side of building envelope insulation without exception. Where risers occur in outside walls, ensure that building insulation is adequate and intact. All piping must be drainable. Provide drains required and all piping shall be run in or above heated portion of the building.

3.3 INSTALLATION OF UNDERGROUND PIPE PROTECTION

A. Apply covering to within four inches of ends for each pipe length on pre-wrapped pipe.

B. Clean all piping of all loose scale, rust, dirt, oil and grease before wrapping. Wire brush as required, use of a quality solvent for removal of oil and grease.

C. Field Joints and Fittings: Joints shall be wrapped to provide at least two full thickness' over the joint and to extend a minimum of 4" over the adjacent pipe covering. Tightly apply the tapes with a one-half minimum uniform lap, free from wrinkles and voids. Experienced operators shall wrap sections of piping to be wrapped that exceed 50' of continuous lengths with an approved wrapping machine.

D. Piping Protective Covering Testing. After applying covering, and before back filling. Test all protective covering using a Tinker and Rasor Holiday Detector, obtain certification upon completion of test. Correct any discovered faults in coating and repeat test until system is proved free of all faults.

E. Inspection: Damaged or defective wraps shall be repaired as directed. Do not cover wrapped pipe until the inspection and necessary repairs have been completed and approved by the Architect.

F. Defect Repair: Tape coat TC Cold prime and double wrap of Tape coat CT cold-applied tape spirally wrapped with half-tape width overlap of preceding layer.

G. Covering: Place all backfill carefully in order not to damage the wrap. No rocks or sharp edges shall be back filled against the wrap.

3.4 EXCAVATING AND TRENCHING

A. Perform all excavations as required for the installation of the work included under this section, including shoring of earth banks to prevent cave-ins and to protect workmen and equipment. Restore all surfaces, roadways, walks, curb, walls, existing underground installations, etc. damaged or cut as a result of the excavations to their original conditions in
a manner approved by the architect. Excavations shall be ample in size to permit pipes or equipment to be laid at elevations intended, and to permit ample space for caulkling and joining and compacting backfill around pipe. Maintain all warning signs, barricades, flares and red signal lanterns as required by the Safety Orders of the Division of Industrial Safety and local ordinances. Perform all pumping required to remove all water from trenches during installation of piping and backfilling.

B. Stop machine excavation for pipe trenches in solid ground, several inches above required grade, so that a firm and uniform bearing throughout entire length of pipe is provided. In lieu of above hand excavation on bottom of trench, the contractor may excavate to a depth one quarter of the nominal diameter of pipe, but in no case excavate less than 6" below required grade line, and place a bed of sand or granular soil, properly compacted to provide a uniform grade and to provide a firm support for pipe throughout its entire length. When pipe or underground conduit with insulation or protective coating is to be placed in the trench, clean sand only shall be used for bedding the pipe or conduit.

3.5 BACKFILLING

A. No backfilling operations shall begin until the required tests and inspections have been made and the Architect has given approval for backfilling. Should any of the work be enclosed or covered up before it has been approved, contractor shall, at his expenses, uncover the work. After it has been inspected, tested and approved, he shall make all repairs necessary to restore the work of the other contractor to the condition in which it was found at the time of uncovering. Insulated pipe and pipe with protective coating shall be backfilled with clean, concrete grade sand for a minimum distance of 12" above the top of the pipe. Compact sand backfill by flooding or jetting. Protect pipe from uplift during jetting operation.

B. Except under existing paved areas, walks, roads, or similar surfaces, and in cases where rock is encountered, backfill more than 12" above the top of the pipe shall be made using suitable excavated material or other approved material as necessary. The backfill shall be placed in 6" layers, measured before compaction, and tamped either by hand or machine.

C. Machine tamping of backfill for excavations under existing or proposed pavement, walks, roads or similar surfaces, and under new slabs on grade, shall be made in accordance with division 02222. Backfill for excavation under pavement, slabs, walks, roads and similar surfaces shall be compacted as specified in division 02222. Surface work shall be replaced to match the existing work. Replace or repair to its original condition all sod, concrete, or other materials disturbed by the trenched or backfilling operation. Remove and dispose of all excess material.

3.6 CROSSING EXISTING UTILITIES

A. Extreme care shall be exercised during excavation across existing utility lines particularly gas and electrical lines for trenched to install new utility lines. Hand excavate all trenches in the proximity of existing lines so as not to damage or cut into them.

B. All existing utility and service lines shall be located by hand excavation prior to trenching with equipment.

C. The location, depth and invert elevations of all existing utilities to be crossed or to which connecting shall be determined before performing any other work or ordering any materials for the project.
3.7 PROTECTION FROM DAMAGE

A. Protect the work and materials of other trades as well as the Mechanical work and material from damage during construction. Cap and/or plug all piping at the completion of roughing-in and before backfilling. Cap all piping at the close of each day.

3.8 PLUMBING FIXTURES

A. All water supplied to fixtures shall be provided with Speedway loose key compression shut-off stops. Combination fixtures shall have compression stop on each water supply fitting. Concealed stops shall be Crane 9H-313 or equal.

B. Provide red brass pipe nipples for all stub-outs thru walls to fixtures or equipment. Do not use copper pipe for stub-outs.

3.9 FINAL CONNECTIONS

A. Plumbing Contractor shall verify location of and make all final connections to site utilities, extend to buildings and furnish and install valves, valve boxes, pressure reducing valves, shut-off cocks, cleanouts, pressure regulating valves, adapters and other accessories shown and/or required to connect.

3.10 FIELD QUALITY CONTROL

A. Water Sterilization

1. After installation and before installing valves or making final connections, flush or purge piping systems clean of foreign substances; use water to flush piping conducting liquids and compressed air to clear piping conducting gases.

2. After completing cold and heated water systems, disinfect in accordance with current requirements of U.S. Public Health Department. Use 50 parts per million of chlorine with 8 hour retention and flush to leave a residual no greater than supply source. Submit written certification of disinfecting completion by independent laboratory. After sterilization take at least one (1) water sample per floor and have analyzed for "E-coli" to submit test results.

END OF SECTION
SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Section 22 11 00, Facility Water Distribution applies to this section.

1.2 SUMMARY
A. This section includes all plumbing (equipment, fixtures, pipe and fittings, specialties) inside the building(s) and outside the building(s) to the point of connection to site plumbing systems.
B. Provide complete plumbing systems including:
   1. Service connections to existing on-site utilities, and stubs for future connection to equipment provided under the work of this Section or other Sections of the Specifications.
   2. All piping systems for conduction of cold water, heated water, soil, waste, fuel gas, and other fluids or gases as shown or specified for plumbing work.
   3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings, piping, and other piping accessories as shown or specified for plumbing work.
   4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.

1.3 RELATED SECTIONS
A. Section 22 05 00 - Plumbing
B. Section 22 07 00 - Insulation
C. Section 21 00 00 - Fire Protection
D. Section 23 00 00 - Heating, Ventilating, & Air Conditioning

1.4 QUALITY ASSURANCE
A. All plumbing fixtures and equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.

1.5 REFERENCES
A. Pipes and Tubes
   3. Fittings


B. Joining Materials
   1. Solder Filler Metal: ASTM B32, alloys to suit system requirements.
   2. Brazing Filler Metals: AWS A5.8, alloys to suit system requirements.

1.6 STRUCTURAL REQUIREMENTS

A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer and approval from DSA. Where possible, offset vents and pipes rising in walls, concealed above ceilings, below plates and rise through roof. Where this is not possible, install vents and pipes through plates as detailed on structural drawings.

1.7 SUBMITTALS

A. Submit a general statement of materials and methods along with manufacturer's technical data and installation instructions for all equipment, fixtures, pipe and fittings, and plumbing specialties to be installed.

B. Record Drawings: Per specification section 22 05 00 requirements.

C. Operation and Maintenance Manuals: Per specification section 22 01 00 requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Adapters: Wrought copper male adapters shall be used wherever it is necessary to connect copper tubing to a valve or "tee" having threaded connections.

2.2 PIPE, FITTING, AND JOINING MATERIALS

A. Copper Water Pipe

   1. Pipe: Above grade, Type M, L, or K hard drawn copper tubing per ASTM B-88, plain ends.


   3. Unions: Solder type, cast red bronze.

   4. Joining Materials/Methods

      a. Canfield, Silvabrite or equal lead free solder with a non-corrosive water based flux.

      b. 15% silver brazing alloy, water based silver brazing flux. Silver content must be clearly identified on the brazing rod.

   5. Connections

      a. Copper to dissimilar metals: dielectric connector.
b. Copper to threaded connections: cast brass adapters.

2.3 PIPE AND FITTING APPLICATIONS

A. Inside Building (to 5'-0" outside building line).
   1. Water Piping: Above grade, Type L drawn temper, joining methods, soldered connections, below grade, Type K drawn temper copper tubing, joining methods, brazed connections.
   2. Plastic pipe and fittings shall not be used inside of buildings.

B. Outside Building (from 5'-0" outside building line)
   1. Domestic Water
      a. 1 ½" and smaller, Schedule 40 PVC, solvent welded, pipe and Schedule 80 fittings.
      b. 2" & 2 ½", Schedule 80 PVC, solvent welded, pipe and Schedule 80 fittings.
      c. 3" and larger, Johns Mansville, C-900, Blue Brut, PVC pipe and fittings, Class 200, installed in strict accordance with manufacturer's published instructions.

PART 3 - EXECUTION

3.1 PIPING

A. Provide trenching and backfill for buried piping and install with the following minimum cover unless shown otherwise, cover is from top of pipe to finish grade.
   1. Water - 30"

B. Water piping
   1. On buried lines larger than 2 ½" size, install concrete thrust blocks between pipe and undisturbed soil of trench wall at each change in direction (tees and ells) for lateral support.
   2. Where laid in same trench with sewer line, install on trench shelf at least 12" above top of sewer pipe.
   3. Where subject to freezing conditions water pipe shall be buried at least 30 inches deep or deeper to protect the water from freezing.
   4. Run water piping generally level. No piping shall be installed to cause an unusual noise from the flow of water under normal conditions.
   5. All water branches as single fixtures shall be provided with air chambers at least 12" long and of the same diameter pipe as the branches. Where two or more fixtures are located in a row or battery, the supply heads shall be continued full-size of the branch outlet and an air chamber same pipe size as the header and a minimum of 24" long shall be installed on the end of the header.
   6. Adapters: Wrought copper male adapters shall be used wherever it is necessary to connect copper tubing to a valve or tee having threaded connections.
   7. Install Bare Metal Pipe Isolators: Stoneman "Trisolator", Superstrut "Cush-a-strip", Unistrut on all hot and cold domestic water piping.
3.2 FIELD QUALITY CONTROL

A. Water Sterilization

1. After installation and before installing valves or making final connections, flush or purge piping systems clean of foreign substances; use water to flush piping conducting liquids and compressed air to clear piping conducting gases.

2. After completing cold and heated water systems, disinfect in accordance with current requirements of U.S. Public Health Department. Use 50 parts per million of chlorine with 8 hour retention and flush to leave a residual no greater than supply source. Submit written certification of disinfecting completion by independent laboratory. After sterilization take at least one (1) water sample per floor and have analyzed for "E-coli" to submit test results.

3.3 PIPING TESTING: TESTING CRITERIA

<table>
<thead>
<tr>
<th>System</th>
<th>Medium</th>
<th>Pressure</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Water</td>
<td>150 psig</td>
<td>4 hours</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Section 22 05 00 applies to this section.

1.2 SUMMARY
   A. This section includes all plumbing (equipment, fixtures, pipe and fittings, specialties) inside
      the building(s) and outside the building(s) to the point of connection to site plumbing
      systems.
   B. Provide complete plumbing systems including:
      1. Service connections to existing on-site utilities, and stubs for future connection to
         equipment provided under the work of this Section or other Sections of the Specifications.
      2. All piping systems for conduction of water as shown or specified for plumbing work.
      3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings,
         piping, and other piping accessories as shown or specified for plumbing work.
      4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.

1.3 RELATED SECTIONS
   A. Section 22 05 00 - Plumbing
   B. Section 22 07 00 - Insulation
   C. Section 21 00 00 - Fire Protection
   D. Section 23 00 00 - Heating, Ventilating, & Air Conditioning

PART 2 - PRODUCTS

2.1 PIPING ACCESSORIES
   A. Unions
      1. Shall have the same pressure rating as pipe fittings.
   B. Check Valves
      1. Swing check, Class 125 Buna-N Disc, NIBCO or equal.
         a. Sizes 2 inch and smaller: Fig. T-413; bronze body, threaded ends, plug type bonnet.
         b. Size 2-1/2 inch and larger: Fig. F-968: iron body, brass mounted, flanged ends,
            bolted bonnet.
   C. Strainers
      1. Watts, Armstrong, Sarco, Arco, Sizes 4" and smaller, Watts Series 777, 400 psi WOG
         bronze body, threaded or soldered ends, 20 mesh stainless steel screen (up to 2 1/2"},
3/64" perforated stainless steel screen (3"), 1/8" perforated stainless steel screen (4"), solid threaded screen retainer cap with gasket.

2. Reduced Pressure Back Flow Preventers

3. 3/4" to 2", Watts Series 909, provide bronze strainer, resilient seated full port bronze ball valves, air gap fitting and drain line, replaceable bronze seats.

4. 2 1/2" to 10", Watts Series 909, provide bronze strainer, non-rising stem resilient seated gate valve shut-offs, air gap fitting and drain line, replaceable bronze seats.

D. Water Pressure Reducing Valves

1. 3/4" to 3", Watts Series 223, provide y-strainer, replaceable stainless steel seat, bronze body construction, water tight sealed cage assembly, removable disc holder, low pressure model adjustable from 10-35 psi, high pressure model adjustable from 50 to 145 psi (1/2" to 1"), 50 to 120 psi (1 1/4"), and 50 to 95 (1 1/2" to 3").

E. Piping Penetration Auxiliaries

1. Sleeves Below Slab or Grade: Metraseal model MS or equal with schedule 80 PVC sleeve. The seal shall be capable of withstanding a hydrostatic pressure of 20 psig. The seal shall be constructed of synthetic rubber with heavy-duty plastic pressure plates. All bolts and nuts shall be constructed of stainless steel.

2. Escutcheons: Polished chrome plated brass or painted metal.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Install equipment in accordance with the manufacturer's installation instructions, as specified herein, and as detailed on the drawings.

3.2 EXTERIOR HOSE BIBBS

A. Install at 18 inches above finished grade and be non-freeze type.

3.3 VALVES, UNIONS AND FLANGES

A. Valves shall be full size of line in which installed. Furnish discs suitable for service intended. All valves shall be properly packed and lubricated. Unions shall be placed adjacent to each threaded or soldered valve or equipment connection 2" and smaller. Install flanges at all valves with stems vertical wherever possible. Stems shall not be placed below horizontal.

B. Install unions adjacent to each valve and at final connection to each piece of equipment.

C. Valves shall be provided with brass identification tags indicating service controlled. Tags may be omitted on lines exposed in equipment rooms where service is obvious.

D. Cathodic Protection: Install insulated flanges or dielectric unions at points of connection between pipes and equipment as follows: (1) between copper or brass piping and steel or cast iron pipe. (2) Between copper or brass piping and any steel material. (3) Buried connections of copper or brass piping to steel or cast iron piping shall be protected with a polyvinyl tape wrap 10 mils thick, extending 5' each way from connection.
E. Expansion: Install piping with sufficient offsets, loops, and/or swing-joints to allow for expansion and contraction. Anchor piping at equipment to restrain movement at those locations.

F. Freeze Protection: Piping shall not be installed in a location subject to freezing conditions. All piping shall and must be installed on the “warm” side of building envelope insulation without exception. Where risers occur in outside walls, ensure that building insulation is adequate and intact. All piping must be drainable; provide drains required. All piping shall be run in or above heated portion of the building.

3.4 FIELD QUALITY CONTROL

A. Water Sterilization

1. After installation and before installing valves or making final connections, flush or purge piping systems clean of foreign substances; use water to flush piping conducting liquids and compressed air to clear piping conducting gases.

2. After completing cold and heated water systems, disinfect in accordance with current requirements of U.S. Public Health Department. Use 50 parts per million of chlorine with 8 hour retention and flush to leave a residual no greater than supply source. Submit written certification of disinfecting completion by independent laboratory. After sterilization take at least one (1) water sample per floor and have analyzed for “E-coli” to submit test results.

B. Piping Testing: Testing Criteria

<table>
<thead>
<tr>
<th>System</th>
<th>Medium</th>
<th>Pressure</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Water</td>
<td>150 psig</td>
<td>4 hours</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - PART 1 - GENERAL

1.1 DESCRIPTION
   A. Provide all equipment, and accessories for the HVAC systems as specified herein; place in satisfactory operation.
   B. Noise and vibration isolation requirements as specified in Section 25 05 48 - Noise and Vibration.
   C. Controls and Instrumentation as specified herein.

1.2 QUALITY ASSURANCE
   A. Welding Qualifications: Welders shall be certified in accordance with American Welding Society "Standard Qualification Procedure".

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL PUMPS
   A. Shall be Bell & Gossett, Paco, Taco, in-line single-stage, single suction, close coupled bronze fitted pumps furnished complete with motor.
   B. Pump housing shall have gauge and drain tappings and shall be of Class 30 cast iron construction suitable for servicing the internal parts without disturbing the connecting piping.
   C. Impeller shall be bronze, enclosed, statically and dynamically balanced, and fitted to shaft with a key and locked in place.
   D. Pump shall have internally flushed mechanical seal with a ceramic seal seat and carbon seal ring fitted with a bronze shaft sleeve that shall completely cover the wetted area under the seal.
   E. See schedule on drawings for size, capacity and duty.
   F. Motors shall have heavy duty grease lubricated ball bearings. All motors over 1 HP shall be NEMA Premium efficiency, Century Model E Plus III, Reliance XE, or equal, 1.15 service factor, single speed. Motor shall be of the enclosure type called for on the plans. Motors shall be able to overcome starting load inertia as well as accelerating the load to rated speed under both rated and at 10 percent reduced voltage conditions during starting without excessive heating.
   G. See schedule for power requirements.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Lubrication: Where equipment includes poorly accessible lubrication points, provide tubing extensions to readily accessible points and terminate with appropriate lubrication fitting.

B. Miscellaneous: Install belt and coupling guards and other miscellaneous items as required.

C. All pump bases shall be grouted.

END OF SECTION
SECTION 22 13 00
FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Section 22 05 00 applies to this section.

1.2 SUMMARY

A. This section includes plumbing waste pipe and fittings, specialties) inside the building(s) and outside the building(s) to the point of connection to site plumbing systems.

B. Provide complete plumbing systems including:
   1. Service connections to existing on-site utilities, and stubs for future connection to equipment provided under the work of this Section or other Sections of the Specifications.
   2. All piping systems for conduction of soil, waste, and other fluids or gases as shown or specified for plumbing work.
   3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings, piping, and other piping accessories as shown or specified for plumbing work.
   4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.

1.3 RELATED SECTIONS

A. Section 22 05 00 - Plumbing
B. Section 22 07 00 - Insulation
C. Section 21 00 00 - Fire Protection
D. Section 23 00 00 - Heating, Ventilating, & Air Conditioning

1.4 STRUCTURAL REQUIREMENTS

A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer and approval from DSA. Where possible, offset vents and pipes rising in walls, concealed above ceilings, below plates and rise through roof. Where this is not possible, install vents and pipes through plates as detailed on structural drawings.

1.5 SUBMITTALS

A. Submit a general statement of materials and methods along with manufacturer's technical data and installation instructions for all equipment, fixtures, pipe and fittings, and plumbing specialties to be installed.

B. Record Drawings: Per specification section 22 05 00 requirements.
   1. Operation and Maintenance Manuals: Per specification section 22 01 00 requirements.
PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 MINIMUM COVER

A. Provide trenching and backfill for buried piping and install with the following unless shown otherwise, cover is from top of pipe to finish grade.

1. Sewer - 30"

3.2 INSTALLATION OF PIPING SYSTEMS

A. General

1. Sleeves: Install sleeves of sufficient size to allow for free motion of pipe. Finish sleeves flush when in walls and extend a minimum of 2" above floor when passing through floor slabs and outside walls shall be caulked with oakum and mastic and made watertight. No visible leakage at sleeves will be permitted. Sleeves may be omitted for waste lines through slabs on grade and rising into a concealed space if wrapped with 1" insulation. Sleeve all pipes where pipes pass through footings with PVC pipe sleeves.

2. Fire-Barrier Penetrations: Seal pipe penetrations with fire-stopping sealant material specified in Division 7.

3. Expansion: Install piping with sufficient offsets, loops, and/or swing joints to allow for expansion and contraction. Anchor piping at equipment to restrain movement at those locations.

3.3 EXCAVATING AND TRENCHING

A. Perform all excavations as required for the installation of the work included under this section, including shoring of earth banks to prevent cave-ins and to protect workmen and equipment. Restore all surfaces, roadways, walks, curb, walls, existing underground installations, etc. damaged or cut as a result of the excavations to their original conditions in a manner approved by the architect. Excavations shall be ample in size to permit pipes or equipment to be laid at elevations intended, and to permit ample space for caulking and joining and compacting backfill around pipe. Maintain all warning signs, barricades, flares and red signal lanterns as required by the Safety Orders of the Division of Industrial Safety and local ordinances. Perform all pumping required to remove all water from trenches during installation of piping and backfilling.

B. Stop machine excavation for pipe trenches in solid ground, several inches above required grade, so that a firm and uniform bearing throughout entire length of pipe is provided. In lieu of above hand excavation on bottom of trench, the contractor may excavate to a depth one quarter of the nominal diameter of pipe, but in no case excavate less than 6" below required grade line, and place a bed of sand or granular soil, properly compacted to provide a uniform grade and to provide a firm support for pipe throughout its entire length. When pipe or underground conduit with insulation or protective coating is to be placed in the trench, clean sand only shall be used for bedding the pipe or conduit.

3.4 BACKFILLING

A. No backfilling operations shall begin until the required tests and inspections have been made and the Architect has given approval for backfilling. Should any of the work be enclosed or covered up before it has been approved, contractor shall, at his expenses,
uncover the work. After it has been inspected, tested and approved, he shall make all repairs necessary to restore the work of the other contractor to the condition in which it was found at the time of uncovering. Insulated pipe and pipe with protective coating shall be backfilled with clean, concrete grade sand for a minimum distance of 12" above the top of the pipe. Compact sand backfill by flooding or jetting. Protect pipe from uplift during jetting operation.

B. Except under existing paved areas, walks, roads, or similar surfaces, and in cases where rock is encountered, backfill more than 12" above the top of the pipe shall be made using suitable excavated material or other approved material as necessary. The backfill shall be placed in 6" layers, measured before compaction, and tamped either by hand or machine.

C. Machine tamping of backfill for excavations under existing or proposed pavement, walks, roads or similar surfaces, and under new slabs on grade, shall be made in accordance with division 02222. Backfill for excavation under pavement, slabs, walks, roads and similar surfaces shall be compacted as specified in division 02222. Surface work shall be replaced to match the existing work. Replace or repair to its original condition all sod, concrete, or other materials disturbed by the trenching or backfilling operation. Remove and dispose of all excess material.

3.5 CROSSING EXISTING UTILITIES

A. Extreme care shall be exercised during excavation across existing utility lines particularly gas and electrical lines for trenching to install new utility lines. Hand excavate all trenches in the proximity of existing lines so as not to damage or cut into them.

B. All existing utility and service lines shall be located by hand excavation prior to trenching with equipment.

C. The location, depth and invert elevations of all existing utilities to be crossed or to which connecting shall be determined before performing any other work or ordering any materials for the project.

3.6 PROTECTION FROM DAMAGE

A. Protect the work and materials of other trades as well as the Mechanical work and material from damage during construction. Cap and/or plug all piping at the completion of roughing-in and before backfilling. Cap all piping at the close of each day.

3.7 FINAL CONNECTIONS

A. Plumbing Contractor shall verify location of and make all final connections to site utilities.

3.8 STUBS

A. All stubs for future connection shall be installed within 12" of location shown. Cap or plug stub at depth specified for service.

B. Furnish and install a #4 Rebar marker pin driven 24" into ground with a white rebar cap 12" above grade at each stub location. Provide brass identification tag.
### 3.9 PIPING TESTING: TESTING CRITERIA

<table>
<thead>
<tr>
<th>System</th>
<th>Medium</th>
<th>Pressure</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage and Vent</td>
<td>Water</td>
<td>10 feet water</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Section 22 05 00 applies to this section.

1.2 SUMMARY

A. This section includes all plumbing (equipment, fixtures, pipe and fittings, specialties) inside the building(s) and outside the building(s) to the point of connection to site plumbing systems.

B. Provide complete plumbing systems including:
   1. Service connections to existing on-site utilities, and stubs for future connection to equipment provided under the work of this Section or other Sections of the Specifications.
   2. All piping systems for conduction of soil, waste, and other fluids or gases as shown or specified for plumbing work.
   3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings, piping, and other piping accessories as shown or specified for plumbing work.
   4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.

1.3 RELATED SECTIONS

A. Section 22 05 00 - Plumbing
B. Section 22 07 00 - Insulation
C. Section 21 00 00 - Fire Protection
D. Section 23 00 00 - Heating, Ventilating, & Air Conditioning

1.4 QUALITY ASSURANCE

A. All plumbing fixtures and equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.

1.5 REFERENCES

A. Pipes and Tubes
   1. Steel Pipe: ASTM A53, Type S, Grade A, Schedule 40, seamless, black or galvanized, plain ends.
   2. Copper Drainage Tube: ASTM B306, Type DWV, drawn temper.

B. Fittings


C. Joining Materials

2. Solder Filler Metal: ASTM B32, alloys to suit system requirements.
3. Brazing Filler Metals: AWS A5.8, alloys to suit system requirements.
4. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.


1.6 STRUCTURAL REQUIREMENTS

A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer and approval from DSA. Where possible, offset vents and pipes rising in walls, concealed above ceilings, below plates and rise through roof. Where this is not possible, install vents and pipes through plates as detailed on structural drawings.
1.7 SUBMITTALS

A. Submit a general statement of materials and methods along with manufacturer's technical data and installation instructions for all equipment, fixtures, pipe and fittings, and plumbing specialties to be installed.

B. Record Drawings: Per specification section 22 05 00 requirements.

C. Operation and Maintenance Manuals: Per specification section 22 05 00 requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Adapters: Wrought copper male adapters shall be used wherever it is necessary to connect copper tubing to a valve or "tee" having threaded connections.

2.2 PIPE, FITTING, AND JOINING MATERIALS

A. Hubless Cast-Iron/Sleeve-Clamped Joints
   1. Pipe: Service weight cast iron, hubless, with hot coal tar pitch coating inside and outside, per Cast-Iron Soil Pipe Institute Standard 301.
   2. Fittings: Hubless type, Tyler No-Hub Coupling, each matched with pipe and identified with the manufacturer's name or trademark, the Cast-Iron Soil Pipe Institute symbol, and the pipe size. Those for connections to other types of piping - approved cast-iron adapter/transition type.
   3. Joining Materials/Methods: Husky Series 4000 (Blue shield) or Mission HeavyWight Orange shield) on pipes over 3", neoprene sleeve type conforming to ASTM C564 specifically designed for connecting hubless cast-iron pipe, coated with manufacturer's recommended lubricant before installing; four type 304 stainless steel band clamps with a type 305 stainless steel worm drive screw, and corrugated shield over sleeve; use standard no-hub couplings on pipe 3" and less
   4. Wedge lock joints at rainwater leaders to underground drain.

B. Clay Sewer Pipe: Bell and Spigot - Wedge-Lock ASTM C-425, or Band Seal Joints with sleeves, ASTM #C-700-78a with ASTM #C 425-T fittings.

C. Steel/Cast-Iron Threaded Drainage Fittings
   2. Fittings: Cast-iron threaded drainage type, black coated, with recessed shoulder and pitched threads, per ASTM A-126, Class B.

D. Copper DWV Pipe: DWV drainage tubing per ASTM B-306-86, plain ends for pipe 1 ½" and larger.
   1. Fittings shall be solder type, wrought copper drainage fittings per ANSI Standard B16.29-86.
   2. Joining Materials/Methods: Canfield, Silvabrite or equal lead free solder with a non-corrosive water based flux.
3. Connections:
   a. Copper to dissimilar metals: dielectric connector.
   b. Copper to threaded connections: cast brass adapters.

E. Steel/Threaded Fittings
1. Pipe: Black or galvanized steel per ASTM A-53 seamless, threaded ends, standard weight Schedule 40 or Schedule 80.
2. Fittings
   a. Black or galvanized (to match pipe) banded malleable iron, threaded, ASTM A-197, 150 lb. standard or 300 lb. extra heavy per ANSI Standard B16.3 (to match pipe schedule).
   b. Black or galvanized (to match pipe) banded cast iron, threaded, per ASTM A-126 Class B, 125 lb. standard or 250 lb. extra heavy per ANSI Standard B16.4 (to match pipe schedule).
3. Unions: AAR 300 lb. malleable iron, black or galvanized (to match pipe).
4. Joining Materials/Methods
   a. Rectorseal or pure lead and graphite thread lubricant.
   b. Permacel, P-412 1/2" wide teflon pipe joint sealant.

F. Polyvinyl Chloride (PVC)/Solvent-fused (Welded) Joints
1. Pipe: Schedule 80, Type I, Grade I PVC, plain ends.
2. Fittings: PVC Schedule 80 socket type.
3. Joining Materials/Methods: Solvent-Fusing (welding), using solvent and methods per manufacturer's recommendations.

G. Polypropylene plastic fusion welded joints
1. Pipe: Schedule 40, plain ends.
2. Fittings: Polypropylene fusion welded type.
3. Joining Materials/Methods: Fusion welded, using fusion welding fittings, and the control unit meeting the following requirements.
   a. Microprocessor controlled
   b. Water proof
   c. Input and output voltage sensors
   d. Ambient temperature sensors
   e. Audible alarms to indicate cycle interruptions and completion of joining process.
4. Connections: Utilize only adapters supplied by the same manufacturer of the pipe.

H. Polypropylene plastic mechanical joints
1. Pipe: Schedule 40, grooved ends.
2. Fittings: Polypropylene type designed to lock into a machined groove on the mating pipe.
3. Joining Materials/Methods: Mechanical joint utilizing fittings and pipe supplied by the same manufacturer.
4. Connections: Utilize only adapters supplied by the same manufacturer of the pipe.

I. Polyethylene plastic butt fusion welded joints
   1. Pipe: Schedule 40, plain ends.
      a. Fittings: Polyethylene fusion welded type.
      c. Connections: Utilize only adapters supplied by the same manufacturer of the pipe.

J. Manville Ring-Tite PVC sewer pipe, SDR-35, ASTM D 3034. Use materials per utility standards off site - where applicable.

K. Johns Manville, C-900, Blue Brut, PVC pipe and fittings, Class 200, installed in strict accordance with manufacturer's published instructions.

L. Johns Manville Blue Brut PVC pipe and fittings U.L. approved for fire protection.

2.3 PIPE AND FITTING APPLICATIONS

A. Inside Building (to 5'-0" outside building line).
   1. Soil, waste and vent piping
      a. Below slab, service weight cast iron soil pipe and fittings, asphaltic coated for sizes 2 1/2" and smaller. Above floor from 6" above slab shall be galvanized steel pipe or service weight cast iron soil pipe and fittings, asphaltic coated for sizes 2 1/2" and smaller. Urinal waste shall be service weight cast iron soil pipe and fittings, asphaltic coated. Sizes 3" and larger shall be service weight cast iron soil pipe and fittings, asphaltic coated.
      b. Fittings
         1) Contractor may use "No-Hub" "Husky" joints per manufacturers published instructions for installation. No-Hub fittings for waste and soil pipe shall be four band stainless steel type. Standard two band stainless steel band type may be used for vent piping.
      c. As an alternate use, copper DWV Pipe.

2. Condensate Drain Piping: Type M, drawn temper copper tube, joining method, soldered connections. Connect to equipment with P-trap and clean out plug.

3. Use PVC pipe for all condensing heating equipment condensate drains.


5. Above grade mechanically-joined polypropylene chemical waste piping system.

6. Plastic pipe and fittings shall not be used inside of buildings, except as permitted for acid waste and vent systems.

B. Outside Building (from 5'-0" outside building line)
   1. Sewers: Sanitary pipe shall be first quality Johns Manville Ring-Tite PVC sewer pipe. Use cast iron pipe and fittings where 12" minimum bury cannot be maintained and other locations where indicated. Use materials per utility standards off site - where applicable.
a. Contractors Option: first quality, extra strength, bell and spigot clay sewer pipe.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Install equipment in accordance with the manufacturer’s installation instructions, as specified herein, and as detailed on the drawings.

3.2 PIPING

A. Provide trenching and backfill for buried piping and install with the following minimum cover unless shown otherwise, cover is from top of pipe to finish grade.
   1. Sewer - 30"

B. Sewer Piping: Run all horizontal sanitary piping inside of the building at a uniform grade of not less than ¼" per foot unless otherwise noted on the drawings. Sewers shall have invert elevations as shown and slope uniformly between given elevations. All drainage piping shall be run as straight as possible and shall have long radius bends. All offsets shall be made at an angle of 45 degrees or less. All vent piping shall be graded so as to free itself quickly of any water or condensation. Where possible, groups of vent risers shall be jointed together with one enlarged outlet through roof.
   1. Install clean-outs of the same diameter of pipe in all horizontal soil and waste lines where indicated and at all points of change in direction and at base of all soil or waste drops. Locate-clean outs not less than 18" from building construction so as to provide sufficient space for rodding. No horizontal runs of more than 100 feet shall be without clean-out.
   2. Clean-outs in floors shall be protected with a cover taped in place and removed at completion of concrete work.
   3. Provide trap at each inlet to sanitary sewer system. Provide trap primers where shown and as required by code.

C. Bury a No. 18 AWG insulated copper locating wire with all non metallic pipe. Copper wire shall have at least 12" above grade at each end.

D. Condensate drain piping
   1. Provide "P" trap having 2" minimum trap seal.
   2. Install trap with top of trap outlet 2" minimum below bottom of condensate collection pan, and within 12" of pan outlet.
   3. Make changes in direction in the condensate drain line using tees; fit the free leg of the tee with a screwed plug for clean-outs. Provide additional such clean-outs where required by code or where necessary for cleaning drain line.
   4. Extend condensate drain line to appropriate disposal point, receptor, or sewer as prescribed by code or shown on drawings.
   5. Insulation: Provide insulation as shown or specified (Section 22 07 00).

3.3 VENT LOCATIONS

A. Plumbing fixture vents have been combined wherever possible to minimize the number of roof penetrations.
B. Roof penetrations have been coordinated with penetrations of other trades, etc.

C. Plumbing contractor shall not shift or relocate vents through the roof or other penetrations from the locations shown without prior approval of the Architect.

3.4 FIELD QUALITY CONTROL

A. Piping Testing:

1. Testing Criteria

<table>
<thead>
<tr>
<th>System</th>
<th>Medium</th>
<th>Pressure</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage and Vent</td>
<td>Water</td>
<td>10 ft water</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Section 22 01 00 applies to this section.

1.2 SUMMARY
A. This section includes all plumbing (equipment, fixtures, pipe and fittings, specialties) inside the building(s) and outside the building(s) to the point of connection to site plumbing systems.
B. Provide complete plumbing systems including:
   1. Service connections to existing on-site utilities, and stubs for future connection to equipment provided under the work of this Section or other Sections of the Specifications.
   2. All piping systems for conduction of cold water, heated water, soil, waste, fuel gas, and other fluids or gases as shown or specified for plumbing work.
   3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings, piping, and other piping accessories as shown or specified for plumbing work.
   4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.

1.3 RELATED SECTIONS
A. Section 22 05 00 - Plumbing
B. Section 22 07 00 - Insulation
C. Section 21 00 00 - Fire Protection
D. Section 23 00 00 - Heating, Ventilating, & Air Conditioning

PART 2 - PRODUCTS

2.1 PIPING ACCESSORIES
A. Cleanouts: Model Numbers are Josam.
   1. Vertical: polished bronze cover.
   2. Floor: nickel-bronze cover, carpet clean out marker in carpeted areas.
   4. Use floor clean outs where located in walks.

2.2 PIPING PENETRATION AUXILIARIES
A. Sleeves Below Slab or Grade: Metraseal model MS or equal with schedule 80 PVC sleeve. The seal shall be capable of withstanding a hydrostatic pressure of 20 psig. The seal shall
be constructed of synthetic rubber with heavy-duty plastic pressure plates. All bolts and nuts shall be constructed of stainless steel.

1. Escutcheons: Polished chrome plated brass or painted metal.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Install equipment in accordance with the manufacturer’s installation instructions, as specified herein, and as detailed on the drawings.

3.2 VALVES AND FLANGES

A. Valves shall be full size of line in which installed. Furnish discs suitable for service intended. All valves shall be properly packed and lubricated. Unions shall be placed adjacent to each threaded or soldered valve or equipment connection 2" and smaller. Install flanges at all valves with stems vertical wherever possible. Stems shall not be placed below horizontal.

B. Valves shall be provided with brass identification tags indicating service controlled. Tags may be omitted on lines exposed in equipment rooms where service is obvious.

C. Cathodic Protection: Install insulated flanges or dielectric unions at points of connection between pipes and equipment as follows: (1) between copper or brass piping and steel or cast iron pipe. (2) Between copper or brass piping and any steel material. (3) Buried connections of copper or brass piping to steel or cast iron piping shall be protected with a polyvinyl tape wrap 10 mils thick, extending 5’ each way from connection.

3.3 FIELD QUALITY CONTROL

A. Piping Testing: Testing Criteria

<table>
<thead>
<tr>
<th>System</th>
<th>Medium</th>
<th>Pressure</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage</td>
<td>Water</td>
<td>10 feet water</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Vent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 22 14 16
RAINWATER LEADERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Section 22 05 0 applies to this section.

B. See 22 07 019

1.2 SUMMARY

A. This section includes all plumbing (equipment, fixtures, pipe and fittings, specialties) inside the building(s) and outside the building(s) to the point of connection to site plumbing systems.

B. Provide complete plumbing systems including:
   1. Service connections to existing on-site utilities, and stubs for future connection to equipment provided under the work of this Section or other Sections of the Specifications.
   2. All piping systems for conduction of soil, waste, and other fluids or gases as shown or specified for plumbing work.
   3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings, piping, and other piping accessories as shown or specified for plumbing work.
   4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.

1.3 RELATED SECTIONS

A. Section 22 05 00 - Plumbing
B. Section 22 07 00 - Insulation
C. Section 21 00 00 - Fire Protection
D. Section 23 00 00 - Heating, Ventilating, & Air Conditioning

1.4 QUALITY ASSURANCE

A. All plumbing fixtures and equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.

1.5 REFERENCES

A. Pipes and Tubes
   1. Steel Pipe: ASTM A53, Type S, Grade A, Schedule 40, seamless, black or galvanized, plain ends.
   2. Copper Drainage Tube: ASTM B306, Type DWV, drawn temper.
B. Fittings

C. Joining Materials
   2. Solder Filler Metal: ASTM B32, alloys to suit system requirements.
   3. Brazing Filler Metals: AWS A5.8, alloys to suit system requirements.

1.6 STRUCTURAL REQUIREMENTS
   A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer and approval from DSA. Where possible, offset vents and pipes rising in walls, concealed above ceilings, below plates and rise through roof. Where this is not possible, install vents and pipes through plates as detailed on structural drawings.

1.7 SUBMITTALS
   A. Submit a general statement of materials and methods along with manufacturer’s technical data and installation instructions for all equipment, fixtures, pipe and fittings, and plumbing specialties to be installed.
   B. Record Drawings: Per specification section 15010 requirements.
   C. Operation and Maintenance Manuals: Per specification section 22 10 00 requirements.
PART 2 - PRODUCTS

2.1 GENERAL

A. Adapters: Wrought copper male adapters shall be used wherever it is necessary to connect copper tubing to a valve or "tee" having threaded connections.

2.2 PIPE, FITTING, AND JOINING MATERIALS

A. Hubless Cast-Iron/Sleeve-Clamped Joints
   1. Pipe: Service weight cast iron, hubless, with hot coal tar pitch coating inside and outside, per Cast-Iron Soil Pipe Institute Standard 301.
   2. Fittings: Hubless type, Tyler No-Hub Coupling, each matched with pipe and identified with the manufacturer's name or trademark, the Cast-Iron Soil Pipe Institute symbol, and the pipe size. Those for connections to other types of piping - approved cast-iron adapter/transition type.
   3. Joining Materials/Methods: Husky Series 4000 (Blue shield) or Mission HeavyWeight Orange shield) on pipes over 3", neoprene sleeve type conforming to ASTM C564 specifically designed for connecting hubless cast-iron pipe, coated with manufacturer's recommended lubricant before installing; four type 304 stainless steel band clamps with a type 305 stainless steel worm drive screw, and corrugated shield over sleeve; use standard no-hub couplings on pipe 3" and less
   4. Wedge lock joints at rainwater leaders to underground drain.

B. Clay Sewer Pipe: Bell and Spigot - Wedge-Lock ASTM C-425, or Band Seal Joints with sleeves, ASTM #C-700-78a with ASTM #C 425-T fittings.

C. Steel/Cast-Iron Threaded Drainage Fittings
   2. Fittings: Cast-iron threaded drainage type, black coated, with recessed shoulder and pitched threads, per ASTM A-126, Class B.

D. Copper DWV Pipe: DWV drainage tubing per ASTM B-306-86, plain ends for pipe 1 ½" and larger.
   1. Fittings shall be solder type, wrought copper drainage fittings per ANSI Standard B16.29-86.
   2. Joining Materials/Methods: Canfield, Silvabrite or equal lead free solder with a non-corrosive water based flux.
   3. Connections:
      a. Copper to dissimilar metals: dielectric connector.
      b. Copper to threaded connections: cast brass adapters.

E. Steel/Threaded Fittings
   1. Pipe: Black or galvanized steel per ASTM A-53 seamless, threaded ends, standard weight Schedule 40 or Schedule 80.
   2. Fittings
a. Black or galvanized (to match pipe) banded malleable iron, threaded, ASTM A-197, 150 lb. standard or 300 lb. extra heavy per ANSI Standard B16.3 (to match pipe schedule).

b. Black or galvanized (to match pipe) banded cast iron, threaded, per ASTM A-126 Class B, 125 lb. standard or 250 lb. extra heavy per ANSI Standard B16.4 (to match pipe schedule).

3. Unions: AAR 300 lb. malleable iron, black or galvanized (to match pipe).

4. Joining Materials/Methods
   a. Rectorseal or pure lead and graphite thread lubricant.
   b. Permacel, P-412 ½" wide teflon pipe joint sealant.

2.3 PIPE AND FITTING APPLICATIONS

A. Inside Building (to 5'-0" outside building line).
   1. Rainwater leader piping
      a. Below slab, service weight cast iron soil pipe and fittings, asphaltic coated for sizes 2 1/2" and smaller. Above floor from 6" above slab shall be galvanized steel pipe or service weight cast iron soil pipe and fittings, asphaltic coated for sizes 2 1/2" and smaller. Sizes 3" and larger shall be service weight cast iron soil pipe and fittings, asphaltic coated.
      b. Fittings
         1.) Contractor may use "No-Hub" "Husky" joints per manufacturers published instructions for installation. No-Hub fittings for waste and soil pipe shall be four band stainless steel type.
         c. As an alternate use, copper DWV Pipe.
   2. Plastic pipe and fittings shall not be used inside of buildings.

B. Outside Building (from 5'-0" outside building line)
   1. Rainwater leaders: Pipe shall be first quality Johns Manville Ring-Tite PVC sewer pipe. Use cast iron pipe and fittings where 12" minimum bury can not be maintained and other locations where indicated. Use materials per utility standards off site - where applicable.
      a. Contractors Option: first quality, extra strength, bell and spigot clay sewer pipe.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Install equipment in accordance with the manufacturer's installation instructions, as specified herein, and as detailed on the drawings.

3.2 PIPING

A. For underground pipe, provide trenching and backfill for buried piping and install with the following minimum cover unless shown otherwise, cover is from top of pipe to finish grade.
   1. Rainwater leaders - 30"

B. Rainwater Leader Piping: Run all horizontal piping inside of the building at a uniform grade of not less than ¼" per foot unless otherwise noted on the drawings. Pipe shall have invert
elevations as shown and slope uniformly between given elevations. All drainage piping shall be run as straight as possible and shall have long radius bends. All offsets shall be made at an angle of 45 degrees or less.

1. Install clean-outs of the same diameter of pipe in all horizontal lines where indicated and at all points of change in direction and at base of all drops. Locate-clean outs not less than 18" from building construction so as to provide sufficient space for rodding. No horizontal runs of more than 100 feet shall be without clean-out.

2. Clean-outs in floors shall be protected with a cover taped in place and removed at completion of concrete work.

3. Provide trap at each inlet to rainwater system.

C. Bury a No. 18 AWG insulated copper locating wire with all non metallic pipe. Copper wire shall have at least 12" above grade at each end.

3.3 FIELD QUALITY CONTROL

A. Piping Testing:

1. Testing Criteria

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</table>

END OF SECTION
SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Section 22 05 00 applies to this section.

1.2 SUMMARY
   A. This section includes all plumbing fixtures.

1.3 RELATED SECTIONS
   A. Section 22 05 00 – Common Work Results For Plumbing
   B. Section 22 07 00 - Insulation
   C. Section 21 00 00 - Fire Protection

1.4 QUALITY ASSURANCE
   A. All plumbing fixtures and equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.

1.5 SUBMITTALS
   A. Submit a general statement of materials and methods along with manufacturer's technical data and installation instructions for all equipment, fixtures, pipe and fittings, and plumbing specialties to be installed.
   B. Record Drawings: Per specification section 22 05 00 requirements.
   C. Operation and Maintenance Manuals: Per specification section 22 05 00 requirements.

PART 2 - PRODUCTS

2.1 GENERAL
   A. See fixture and equipment schedules on drawings.

PART 3 - EXECUTION

3.1 PLUMBING FIXTURES
   A. All fixtures shall be furnished as scheduled. All finished plumbing shall be accurately lined up and where batteries of fixtures occur, special care shall be taken with the roughing-in and finished plumbing.
   B. The number and position of all plumbing fixtures are shown on the plumbing drawings. Consult architectural drawings for the location dimensions and mounting heights of fixtures. Heights shall comply with the 2016 C.B.C., the latest handicapped requirement, and all ADA requirements.
C. All water supplied to fixtures shall be provided with Speedway loose key compression shut-off stops. Combination fixtures shall have compression stop on each water supply fitting. Concealed stops shall be Crane 9H-313 or equal.

D. Provide red brass pipe nipples for all stub-outs thru walls to fixtures or equipment. Do not use copper pipe for stub-outs.

E. All finish for exposed metal trim on any fixture shall be polished chromium plated. This shall include wall flanges, nuts, and washers. Handles on all faucets and stops shall be of all metal, chromium plated. Porcelain caps secured with putty shall be provided and installed for all exposed bolt heads.

F. All fixtures shall be properly and securely installed and supported as required and approved. Fixtures set against concrete walls shall be bolted thereto. Fixtures secured to partitions shall be securely bolted to the wall carrier fittings with foot supports, and shall be provided in types as required to suit the particular installation and fixture.

G. Connection between fixtures and flanges on soil pipe shall be made absolutely gas tight and water tight with graphite type gaskets (wall hung fixture) or Fedar’s closet setting compound (floor outlet fixtures). Rubber gaskets, or putty will not be permitted.

H. Fixtures not having integral traps shall be provided with "P" traps of chromium plated solderless seamless brass with trap screw at bottom and connected to concealed waste in wall sanitary fittings. All trap tail pieces shall be 17 gauge minimum.

I. Unions on waste pipes on fixture side of traps may be slip or flange joints with soft rubber or lead gaskets.

J. All flush valves shall be tested and adjusted so that each fixture receives the proper amount of water. All faucets, hose bibbs, drinking fountains, etc., shall be properly regulated to the approval of the Architect.

K. Comply with State handicapped requirements regarding flow control devices, fixture mounting heights, insulation of piping under fixtures, etc.

L. Furnish and install stainless steel Hudee frames for counter mounted fixtures unless "Self-Rimming".

M. Grout all voids between fixtures and adjacent surfaces with 100% white Dow Silicon sealant.

N. All hot water fixtures except kitchen and janitors sinks to be provided with tempering valves set at 110F (unless served by tempered water systems).

END OF SECTION
DIVISION 23
HEATING, VENTILATING, AND AIR-CONDITIONING
SECTION 23 01 00

OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 ALL LEVELS OF 23 00 00.

1.3 SUBMITTALS

A. Preparations.
   1. Prior to data collection and compilation, prepare and submit in duplicate an outline of the proposed organization and content.
   2. Compilation: Prepare and collect data concurrently with construction progress. Compile per submitted outline.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE MANUALS

A. Form of Submittals
   1. Prepare data in form of an instructional manual for use by Owner's personnel.
      a. Cover: Identify each volume with typed or printed title, "OPERATING AND MAINTENANCE INSTRUCTION". List:
         b. Title of Project.
         c. Provide indexed tabs.
         d. Identify of separate structure as applicable.
         e. Identity of general subject matter covered in the manual.
   2. Format:
      a. Size: 8 ½" x 11".
      b. Paper: 20-pound minimum, white, for typed pages.
      c. Text: Manufacturer's printed data, or neatly typewritten.
      d. Drawings:
   3. Provide reinforced punched binder tab, bind in with text.
   4. Fold larger drawings to size of text pages.
      a. Provide fly-leaf for each separate product, or each piece of operating equipment.
   5. Provide typed description of product and major component parts of equipment.
   6. Provide indexed tabs.
   7. Binders:
      b. Maximum ring size: 1".
      c. When multiple binders are used, correlate the data into related consistent groupings.
PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE DATA

A. General: Record data and operation and maintenance data are complimentary. Submittal items which may be required under both categories may be included only under one submittal if a statement to that effect is included in the other submittal.

B. Quality Assurance
   1. Preparation of data shall be done by personnel.
      a. Trained and experienced in maintenance and operation of described products.
      b. Familiar with requirements of this Section.
      c. Skilled as technical writer to the extent required to communicate essential data.
      d. Skilled as draftsman competent to prepare required drawings.

C. Content of Manual
   1. Neatly typewritten table of contents for each volume, arranged in systematic order.
      a. A list of each product required to be included, indexed to content of the volume.
      b. List, with each product, name, address and telephone number of:
         1) Subcontractor or installer.
         2) Maintenance contractor, as appropriate.
         3) Identify area of responsibility of each.
         4) Local source of supply for parts and replacement.
      c. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
   2. Product Data:
      a. Include only those sheets which are pertinent to the specific product.
      b. Annotate each sheet to:
         1) Clearly identify specific product or part installed.
         2) Clearly identify data applicable to installation.
         3) Delete references to inapplicable information.
   3. Drawings:
      a. Supplement product data with drawings as necessary to clearly illustrate.
         1) Relations of component parts of equipment and systems.
         2) Control and flow diagrams.
      b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation
      c. Do not use Project Record Documents as maintenance drawings.
   4. Written text, as required to supplement product data for the particular installation.
      a. Organize in consistent format under separate headings for different procedures.
      b. Provide logical sequence of instructions for each procedure.
a. Provide a factory start-up report for each piece of equipment. Contractor start-up reports, unless contractor is a factory authorized representative will not be allowed.

6. Copy of each warranty, bond and service contract issued.
   a. Provide information sheet for Owner's personnel, give:
      1) Proper procedures in event of failure.
      2) Instances which might affect validity of warranties or bonds.

D. Manual for Equipment and Systems:
   1. Submit three copies of complete manual in final form.
   2. Content, for each unit of equipment and system, as appropriate.
      a. Description of unit and component parts.
         1) Function normal operating characteristics, and limiting conditions
         2) Performance curves, engineering data and tests.
         3) Complete nomenclature and commercial number of replaceable parts.
      b. Operating procedures:
         1) Start-up, break-in, routing and normal operating instructions.
         2) Regulation, control, stopping, shut-down and emergency instructions.
         3) Summer and winter operating instructions.
         4) Special operating instructions.
      c. Maintenance Procedures:
         1) Routing operations.
         2) Guide to "trouble-shooting"
         3) Disassembly, repair and reassemble.
         4) Alignment, adjusting and checking.
      d. Servicing and lubrication schedule.
         1) List lubricants required.
      e. Manufacturer's printed operating and maintenance instructions.
      f. Description of sequence of operation by control manufacturer.
      g. Original manufacture's parts list, illustrations, assembly drawings and diagrams required for maintenance.
         1) Predicted life of parts subject to wear.
         2) Items recommended to be stocked as spare parts.
      h. As-installed control diagrams by controls manufacturer.
      i. Each contractor's coordination drawings:
         1) As-installed color-coded piping diagrams.
      j. Charts of valve tag numbers, with location and function of each valve.
      k. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
      l. Other data as required under pertinent sections of specifications.
m. Content for each electric and electronic system, as appropriate.
n. Description of system and component parts.
   1) Function, normal operating characteristics, and limiting conditions.
   2) Performance curves, engineering data and tests.
   3) Complete nomenclature and commercial number of replaceable parts.
o. Circuit directories of panel boards.
   1) Electric service.
   2) Controls.
   3) Communications
p. As-installed color coded wiring diagrams.
q. Operating procedures.
   1) Routing and normal operating instructions.
   2) Sequences required.
   3) Special operating instructions.
r. Maintenance procedures.
   1) Routine operations.
   2) Guide to “trouble shooting”.
   3) Disassembly, repair and reassembly.
   4) Adjustment and checking.
s. Manufacturer’s printed operating and maintenance instructions.
t. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.
u. Other data as required under pertinent sections of specifications.
v. Additional requirements for operating and maintenance data: Respective sections of Specifications.

E. Submittal Schedule
   1. Submit two copies of preliminary draft of proposed formats and outlines of contents prior to start of work.
   2. Architect will review draft and return one copy with comments.
   3. Submit one copy of complete data in final form fifteen days prior to final inspection or acceptance.
   4. Copy will be returned after final inspection or acceptance, with comments.
   5. Submit specified number of copies of approved data in final form 10 days after final inspection or acceptance.

F. Instruction of Owner’s Personnel.
   1. Prior to final inspection or acceptance, fully instruct Owner’s designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems
   2. Operating and maintenance manual shall constitute the basis of instruction.
a. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

END OF SECTION
SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section applies to all Division 23 Mechanical Sections.

1.2 SUMMARY

A. Furnish and install all mechanical work shown on the drawings, specified herein, and as required for a complete and functional installation.

B. This section includes materials and methods applicable to the work described in all Division 23 Mechanical Sections. Specific work requirements of individual Mechanical Sections take precedence if in conflict with requirements of this Section.

C. All chemicals utilized on site as part of coating, sealant, and other products shall not contain any chemical that is listed as part of Proposition 65 known carcinogens that are identified by NTP, IARC, and the USEPA California Proposition 65 chemical repository contractors are not allowed to bring these chemicals on any California Intel site.

1.3 RELATED SECTIONS

A. Division 3 - Concrete Work

B. Division 26 - Electrical Work

C. Division 22 - Plumbing

1.4 DRAWINGS AND SPECIFICATIONS

A. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, the Contractor shall make use of all data in all the contract documents and shall verify this information at building site.

B. Information presented on Drawings and in the Specifications is based upon latest data available during their preparation. The Drawings and Specifications are for the assistance and guidance of the Contractor and exact locations, distances, levels, etc. will be governed by the structures and the site the contractor shall accept same with this understanding.

C. The drawings indicate required size and points of termination of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of the Contractor to make the installation in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep openings and passageways clear.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall be responsible for delivery, storage, protection and placing of all equipment and materials.
B. Equipment stored and installed at the job site shall be protected from dust, water or other damage. Cover all equipment stored exposed to weather.

1.6 STRUCTURAL REQUIREMENTS

A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer.

1.7 SEISMIC RESISTANCE

A. See Section 23 05 48.

1.8 CODES AND SAFETY ORDERS

A. All work and materials shall be in full accordance with the latest rules and regulations of the State Fire Marshall; the Safety Orders of the Division of Industrial Safety; the I.S.O. codes; the 2016 California Plumbing Code, Title 24, Part 5; the 2016 California Mechanical Code, Title 24, Part 4; the 2016 California Building Code, Title 24, Part 2, 2016 NFPA Codes, and other applicable laws and regulations. Nothing in the Drawings or Specifications shall be construed to permit work not conforming to these codes. Drawings and Specifications take precedence when work and materials called for exceed Code requirements.

1.9 INSTALLATION

A. Manufacturer’s Instructions:
   1. When specifications require that installation comply with manufacturer’s printed instructions, obtain and distribute copies of such instructions to parties involved in the installation.
   2. Perform work in accordance with manufacturer’s instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by specifications.
   3. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.
   4. Should job conditions or specified requirements conflict with manufacturer’s instructions, consult with the Engineer for further instructions.
   5. Do not proceed with work without clear understanding.

1.10 PERMITS AND FEES

A. Obtain all permits and pay all required fees for permits and/or utility services. Inspections required during the course of construction shall be arranged as required. On completion of the work furnish the owners representative with certificates of inspection.

B. Include in bid all costs for gas service including meter, regulators and service line installed by a gas utility company or a gas utility company approved contractor.

1.11 SITE CONDITIONS

A. Assume all responsibility for damage to adjoining properties; and restore property to its original condition, should damage occur as a result of the work of this section. Contractor shall thoroughly familiarize himself with all site conditions. Should utilities not shown on the drawings be found during excavations, promptly notify the Architect for instructions as to
further action. Failure to do so will make the Contractor liable for any and all damage thereto arising from his operations subsequent to discovery of such utilities not shown on plans.

1.12 SUBMITTALS

A. General

1. A submittal schedule shall be issued by the contractor within 15 days of award of the contract. This schedule shall allow for timely review and approval as required by the contract documents.

2. These requirements apply only to substitutions, submittals, and shop drawings.

3. The contractor shall review all submittals prior to submission to the Architect. Submittals not reviewed by the contractor will be returned to the contractor and will not be reviewed.

4. Any deviations from specified requirements shall be clearly indicated in submittals.

5. Any errors in or omissions from submittals and any consequences of these are the responsibility of the Contractor.

6. Partial or incomplete submittals may be rejected as not complying with requirements; the Contractor shall be liable for any resultant consequences.

7. Delayed submittals may be rejected as not complying with requirements. Whether accepted or rejected, delayed submittals will not be considered justification for extension of contract time or similar relief.

8. Submittals not required or permitted by the Specifications but made at the option of the Contractor, will be returned without review unless accompanied with written valid justification.

9. Submittal items improperly included with those of another category (such as a proposed substitution included with shop drawing submittal) are not valid and will be returned without review.

10. Within 35 calendar days after award of the contract, and before fabrications and installation of any material or ordering of any materials, submit for approval one copy in PDF format of complete submittal data on specified and proposed substituted equipment and materials. Submittals shall list all materials proposed identified with drawing symbols and specific data on equipment such as arrangements, performance curves, sizes, capacity, motor locations, and other pertinent data. Check all submittals for conformance to the requirements of the Construction Documents before forwarding to the architect for each item. No consideration will be given to substitutions submitted past 35 day limit. The contractor shall be responsible for all quantities and errors and omissions of submittals. Furnish samples when requested.

11. Equipment and materials specified as part of the specifications and drawings are listed by two manufacturers names. The first named manufacturer is the basis of design. The second named manufacturer has been determined to be an equivalent in quality or utility. The second named has not been specifically determined to conform to the first named in size, layout, electrical power, voltage, or impacts to building structure. The contractor is bound by all requirements for substitutes, as described below, for all second named manufacturers and equivalent equipment or products.

12. Each reviewed submittal will be marked to indicate review and directions as stated below.
13. Acceptance of a submittal does not relieve the Contractor of responsibility for omissions from the submittal or errors in the submittal.

1.13 REVIEW

A. Submittals will be reviewed for general acceptability, not necessarily including all details. The engineers review is for general conformance with the design concept of the project and the information given in the contract documents. The contractor is solely responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating the work with that of other trades and performing all work in a safe and satisfactory manner. Corrections of comments made on this submittal during this review do not relieve contractor from compliance with the requirements of the contract documents or with its responsibilities listed herein.

1. Proposed substitutes will be judged not only for the acceptability of the items themselves, but also how they will be used under the conditions of the particular project.

2. Proposed substitutions will be judged also for compliance with qualifications and conditions stipulated in paragraph 1.16.

B. Each reviewed submittal will be marked to indicate review and directions as stated below.

1. Acceptance of a substitute does not waive the specified requirements.

2. Once a substitution is accepted, no revision or resubmittal may be made except for pressing and valid reason and after receipts of approval to do so.

1.14 REVIEW DIRECTIONS

A. The notation "No Exceptions Taken" indicates that no further submittal on the particular matter is required and that the Contractor may proceed with normally ensuing action. The notation may be applied to submittals on substitutions, shop drawings, record data, or operation and maintenance data. The submittal has only been reviewed for general conformance with the design concept of the Contract Documents. The contractor is responsible for the dimensions to be confirmed and correlated at the job site; information that pertains solely to the fabrication process or to the means and methods of construction; coordination of the work of all trades; and performing all work in a safe and satisfactory manner. This notation does not modify the contractor's duty to comply with the contract documents.

B. The notation "Make Corrections Noted" indicates that no further submittal on the particular matter is required, but the Contractor shall make all changes or corrections noted (but no others) before proceeding with normally ensuing action. The notation may be applied to submittals on substitutions or shop drawings (but usually not record data or operation and maintenance data).

C. The notation "Amend and Resubmit" indicates that the submittal is not accepted and must be revised, resubmitted, and reviewed again. In the case of submittal on substitutions and shop drawings so noted, the Contractor shall not proceed with any normally ensuing action until the resubmittal is reviewed. The notation may be applied to submittals on substitutions, shop drawings, record data, or operation and maintenance data.

D. The notation "Rejected - See Remarks" indicates that the submittal is not accepted and that resubmittal on the same subject matter is not allowed and will not be considered. The notation will be applied normally only to submittals on substitutions (usually not on shop drawings, record data, or operation and maintenance data).
E. The notation "Returned Without Review" indicates that the submittal or item has not been considered officially because it is either not proper, valid, required, or permitted by the Specifications and has no status or effect.

1.15 SHOP DRAWINGS

A. The contractor is responsible for providing all shop drawings as described below so that the design professional has the opportunity to determine if the contractor understands the contract documents. It is not the purpose of shop drawings to assure that the contractor is meeting the requirements of the contract documents. Review and approval of a submittal neither extends nor alters any contractual obligation.

B. Accompany all substituted equipment with shop drawings showing revised ductwork and/or piping layouts in order to ascertain that substituted equipment does not adversely affect layout or work of others. Shop Drawings: The following conditions apply to shop drawings:
   1. Shop drawings are not and do not become Contract Documents.
   2. Processed shop drawing submittals and any instructions or requirements noted thereon are a part of the work, but they may not be used as a means of increasing the scope of the work.
   3. If deviations, discrepancies, or conflicts between shop drawing submittals and the Contract Documents are discovered either prior to or after the submittals are processed, the Contract Document requirements shall govern.

1.16 SUBSTITUTIONS

A. Whenever any equipment, material, or process is indicated or specified by patent of proprietary name and/or name of Manufacturer, in the Specifications and/or on the Drawings, it is understood that such specification is used to facilitate the description of the material and/or process and deemed to be followed by the words "or equal" unless noted "no substitute".

B. Substitute equipment and materials shall be equal in all respects including quality, arrangement, utility, physical size, capacity, and performance to those specified. Approval of substitute material will not relieve the contractor from complying with the requirement of the Drawings and Specifications. The contractor shall be responsible and at his own expense, for any changes caused by proposed substitutions which affect other parts of his own work or the work of other contractors.

C. The submittal of a proposed substitution shall clearly establish the following:
   1. The item can be transported into and installed in the intended space and in the manner shown.
   2. Required connections (electrical, piping, and other) can be properly made and adjoining work can be properly accomplished.
   3. The proposed substitute is similar to and of substance equal to that specified, is suited to the same use as that specified, and will perform the functions required by the design.
   4. Motors for proposed substitute equipment will have the same minimum differential between motor brake horsepower and motor nameplate horsepower as the specified equipment.
5. All performance requirements shall be at least equal to the specified product or
equipment including noise levels, cooling capacity, heating capacity, air flow quantity,
etc.

**D. By submitting a proposed substitution, the Contractor agrees to the following:**

1. He will assume full responsibility for any and all modifications and necessary alterations
   arising from the use of the substitute item or material including all cost incurred by all
   other trades.

2. He will assume full responsibility for any delay in the construction schedule resulting
   from the use of the substitution.

3. He will prove harmless and indemnify the Owner and the Owner's design consultants
   from real or alleged damages that may result from the installation, use, or performance
   of a substitute material or product.

**E. The following conditions apply to substitutions:**

1. Submittals of substitutions are not and do not become part of the Contract Documents.

2. Contractor shall not order, fabricate, use, or install any substitute product or procedure
   unless he has received acceptance of the substitute from the Engineer.

3. Should the Contractor install any substitute product in violation of the above he shall
   remove it and install the specified product at his own expense.

4. The Contractor shall provide a letter stating that all the above items shall apply to all
   substituted products and equipment.

5. Any submittal for substituted equipment or product that does not clearly show that the
   substituted item is equal shall be marked rejected and no further submittal shall be
   allowed on the substituted item. Provide in submittal format documentation that the
   proposed item is exactly as specified in the contract documents.

**1.17 GUARANTEE**

A. Guarantee all work for one year from date of acceptance, against all defects in material,
   equipment and workmanship including repair of damage to any part of the premises
   resulting from leaks or other defects in material, equipment and workmanship. Guarantee
   shall be on form supplied by the owner's representative.

**1.18 RECORD DRAWINGS**

A. Indicate on reproducible drawings the actual location of all ductwork, piping and equipment
   as the work progresses. Dimension locations of underground service mains and branches.
   Deliver the drawings to the architect at the completion of the job.

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS**

A. Shop drawings:

1. Make all drawings to an appropriate scale, large enough to show all pertinent aspects of
   the item and the method of its connection into the work.

2. Make each drawing sheet in a reproducible form, CAD, Revit or PDF.
B. Grouping: Combine submittals in logical groupings; for example, submit Shop Drawings grouped by Sections of the Specifications, arranged in the specified sequence.

C. Shop Drawings: Four blue or black line prints of each for the Engineer.

D. Content:
   1. Shop drawings may be:
      a. Drawings or diagrams prepared by the Contractor, a supplier, a manufacturer, or other.
      b. Typewritten data or descriptions.
      c. Manufacturer’s printed brochures, descriptions, charts, instructions, or data sheets.

E. Timing: Submit all shop drawings prior to installation of any items included in submittal.

2.2 CORROSION PROOFING

A. Corrosion Proofing / U.V. Protection: Products which will be installed outdoors, exposed to the weather, exposed to moisture, or other potentially damaging conditions shall be constructed to resist the effects of such exposure.

B. Exterior casings shall have lapped or gasketed joints effectively sealed to prevent intrusion of moisture or other injurious substances.

C. Casings, ducts, pipes, or product items shall be constructed of materials which are fully resistant to harmful substances they may normally contact, or (if ferrous) shall be galvanized after fabrication, or shall be fully protected from such substances by paint or other coating in appropriate thickness or number of coats.

D. All bolts, nuts, screws, and washers shall be galvanized unless specified to be plated or unprotected.

E. Any exposed plastic pipe must have a U.V. inhibitor.

2.3 MATERIAL AND EQUIPMENT

A. All material and equipment shall be new, of the type, capacity and quality specified and free from defects. All materials and equipment shall be of the same brand or manufacturer throughout for each class of material or equipment wherever possible.

2.4 FILTERS

A. A complete set of filters shall be supplied for use during the construction period. A complete set of new filters shall be installed before testing and balancing.

2.5 ACCESS BOXES

A. For below grade valves and piping devices
   1. Christy Concrete Products Company, Brooks, with galvanized steel checker plate recessed traffic lid flush with rim of box. Lids for boxes located in areas subject to vehicular traffic shall be constructed to withstand H20 live loading as defined by the American Association of State Highway Officials (16,000 pound maximum individual wheel load). Service identification shall be conspicuously welded on lid before galvanizing. For gas service, drill twelve 3/8" diameter vent holes through lid before
galvanizing. Provide manufacturer's box extensions to bring box bottom three inches below bottom of valve and box top flush with finish grade.

2. Box sizes (non traffic)

<table>
<thead>
<tr>
<th>Type Valve</th>
<th>Valve Size</th>
<th>Box No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>2 1/2'' and smaller</td>
<td>B-9</td>
</tr>
<tr>
<td>Water</td>
<td>3'' and 4''</td>
<td>B-16</td>
</tr>
<tr>
<td>Water</td>
<td>5'' and 6''</td>
<td>B-30</td>
</tr>
<tr>
<td>Gas</td>
<td>1 1/2'' and smaller</td>
<td>B-24</td>
</tr>
<tr>
<td>Gas</td>
<td>2'' and 2 1/2''</td>
<td>B-36</td>
</tr>
<tr>
<td>Gas</td>
<td>3'' and 4''</td>
<td>B-40</td>
</tr>
</tbody>
</table>

2.6 ACCESS DOORS

A. Unless specified otherwise by the Architect, provide access doors of the following type:

1. Concealed hinges, prime coated with rust-inhibitive paint, style of door to suit wall, ceiling, floor or roof construction and fire rating.
   a. Milcor Type M
      1.) Architectural grade, one-piece frame, 16 gauge frame & door panel on concealed spring hinges, grey powder coated steel, Elmdor/Stonman or equal.
   b. Milcor Type UFR, fire resistive type Underwriters Laboratory Class B, 1-1/2 hour rating meets UBC, IBCO and BOCA codes for two hour rated walls self latching with key lock, Elmdor/Stonman Type FR or equal.

2. Minimum size; 18'' by 18''.

3. Wall and ceiling access doors: Furnish as required for access to ducts, damper operators, duct mounted access panels, etc.; coordinate size and location to obtain access.

4. See architectural drawings for further requirements.

2.7 MISCELLANEOUS EQUIPMENT AND MATERIALS

A. Furnish and install miscellaneous equipment and materials required for the systems described whether or not specifically shown.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:

1. Do not install any equipment, valve, control, motor, filter, or any other device requiring maintenance or service in an inaccessible location or position. Install access doors as specified herein to render all such equipment serviceable whether specifically shown on the plans or not. Maintain code clearance to all equipment. Coordinate location of doors with lights, etc., and locate symmetrically with same.

B. Observations: Check all project drawings and specifications; report any discrepancies before proceeding with the work and in time to avoid unnecessary rework.
C. Investigation: Examine the areas, conditions, and status of other work contiguous or connecting to the work to be performed; ensure that the time of installation is coordinated with other work.

D. Interruptions of Service: Portions of this work may involve connection to existing work, facilities, or utilities ties and may require interrupting shutdowns of same. Carefully plan, coordinate and execute such work so that any interruptions will be kept to a minimum in time and occurrence. Submit request for shutdowns and make shutdowns only after receiving written approval from the Owner.

E. Other: Correct any unsatisfactory conditions that may impede proper execution of the work. Ensure that all arrangements, personnel, materials, and tools are appropriate and adequate before proceeding.

3.2 INSTALLATION

A. General:
   1. Material and equipment incorporated in the work shall be used or applied only for the purpose intended or specified.
   2. Install piping and ductwork and all equipment that requires access with minimum vertical and horizontal clearances required by OSHA for service.
   3. All mechanical systems such as ductwork, pipes and all other equipment shall have 2 inches minimum clearance.
   4. Do not proceed with work without clear understanding.

3.3 MANUFACTURER’S INSTRUCTIONS

A. When specifications require that installation comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation.

B. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by specifications.

C. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.

D. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with the Engineer for further instructions.

E. Do not proceed with work without clear understanding.

3.4 DEMOLITION

A. General
   1. Procedures shall be determined by the contractor.
   2. Demolition work shall not be commenced until all temporary work such as fences, barricades, and any required warning lights and apparatus are furnished and installed and as required by law, regulation, or ordinance, or elsewhere in this specification.
   3. Demolition work shall proceed in such a manner as to minimize the spread of dust and flying particles and to provide safe working conditions for personnel.
   4. Fires and explosives shall not be permitted.
3.5 PROTECTION

A. Contractor shall conform to all Federal, State, and local ordinances related to the protection of the public and Contractor's personnel and the flow of traffic. Provide protection for persons and property throughout the progress of the work.

B. Existing work damaged by the contractor in the execution of this Contract shall be restored to former condition by the contractor to the satisfaction of the Owner without an increase in the Contract Sum and without an extension of the Contract Time.

3.6 DISPOSITION OF MATERIALS

A. All materials and equipment not scheduled to be salvaged, including debris and all rejected salvaged materials, shall become the property of the Contractor and shall be disposed of off site in a legal manner. Location of dump and length of hall shall be the contractor's responsibility.

3.7 LOCATION OF EQUIPMENT, PIPING AND DUCT WORK

A. Where job conditions do not permit the installation of piping, ductwork, etc. in the location shown, it shall be brought to the engineer's attention immediately before fabrication of ductwork, piping, etc. and the relocation required shall be determined in a joint conference.

B. The contractor will be held responsible for the relocating of any items installed without first obtaining the architect's or engineer's approval. Remove and relocate such items at the contractor's expense as so directed by the architect or engineer.

C. Where piping or ducting is left exposed within a room, run in vertical or horizontal planes. Maintain uniform spacing between parallel lines and/or adjacent wall, floor or ceiling surfaces.

D. Horizontal runs of plumbing and/or electrical conduit suspended from ceilings shall provide for maximum clearance.

E. Make minor changes in locations of equipment, piping, ducts, etc. from locations shown including minor offsets when directed by the engineer, at no additional cost to the owner.

3.8 CARE AND CLEANING

A. Clean and adjust all equipment at completion of installation to provide operating conditions satisfactory to the engineer. Remove broken, damaged or defective parts; repair or replace as directed by engineer. Remove surface material and debris resulting from this work when directed.

3.9 FLASHINGS

A. Furnish and install a waterproof flashing for each pipe, duct, or other penetration through roof or wall. Flashings shall be 4 lb. seamless lead flashings Semco 1100 series with counter flashing as detailed, except in metal roofs flashing for pipes through roof shall be furnished by the roofing contractor. Where details are not specifically delineated, submit details for review.
3.10 PAINTING

A. Painting is included under the Painting and Finishing Section. It shall be the responsibility of the Mechanical Contractor to properly protect all equipment and controls during painting operations and the Mechanical Contractor shall repair and/or replace any item damaged due to painting that was not properly protected.

3.11 ACCESS DOORS

A. Provide access doors to all concealed equipment, valves, controls, etc. Locate doors where shown or to be coordinated and symmetrically located with lights, diffusers, etc. Access doors furnished by the mechanical contractor shall be installed by the general contractor.

3.12 ELECTRICAL REQUIREMENTS

A. Provide working space around electrical equipment in compliance with the applicable Code and all Safety Orders.

B. Coordinate the Mechanical Work with the Electrical Work to comply with the above. Furnish and set in place all motors and duct or pipe installed controls.

C. Location of all new switches shall be verified with the architect or architect before roughing-in. Furnish necessary control diagrams and instruction for the proper installation of the controls.

D. Assume responsibility for the proper supervision and testing of the controls for sequence of operation.

E. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers Association.

F. All equipment electrical characteristics shall be as noted on the drawings, or as specified. Verify before ordering any equipment.

G. Before permitting operation of any equipment which is furnished, installed or modified under this contract, review all wiring connections that pertain to mechanical equipment or work, and verify that these connections are correct.

H. Ascertain that the over-load protection devices installed are of the correct type, rating and setting to properly protect this equipment.

3.13 INSTRUCTION OF OWNER’S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner’s designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems.

B. Operating and maintenance manual shall constitute the basis of instruction.
   1. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.
3.14 RECORD DATA

A. Compilation

1. Record and collect information concurrently with construction progress and date all entries; make drawing entries within 24 hours after occurrence of change or installation requiring recording. Any concealed work covered before recording data shall be uncovered as directed or as necessary to obtain data.

2. Record information on drawing prints using an erasable colored pencil (not ink or indelible pencil); describe clearly by note or graphic line as appropriate.

B. Locate any concealed work adequately to allow future access with reasonable ease and accuracy.

1. Identify the plan location of all stub outs, pipe lines, etc., which are buried or concealed in the structure, whether installed where shown on the contract drawings or in a different location; show actual field dimensions from column lines, wall lines, or other permanent reference lines or points.

2. In many cases on the contract drawings, the arrangement of conduits, pipes, ducts, and similar items is shown schematically rather than as a precise scaled layout. Identify the actual location of these with horizontal and vertical dimensions. If such lines are exposed or readily accessible, omit dimensional identification.

3. When any work is installed of size, dimension, slope, or location different from that shown on the contract drawings, note the deviation on the Project Record set. If the variations are substantial or cannot be shown clearly on the record drawings, make a new drawing and attach to the Record set.

C. On other documents

1. Where changes occur in specifications, clearly indicate same in ink, colored pencil, or rubber stamp.

2. Where installed equipment differs from that specified (e.g., by accepted substitution or change order) note in the specifications and include complete data on same.

END OF SECTION
SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SEE SECTION 23 05 00

PART 2 - PRODUCTS

2.1 MOTOR

A. Motors furnished as part of mechanical equipment shall be of size indicated and shall have
starting torque sufficient to start and drive equipment load to which they are connected.

B. Electric motors shall be NEMA Premium efficiency, Gould "E 3Plus,", or equal. Provide
motors with maximum efficiency and power factor at their normal load operating point.

C. Motor enclosures shall be:
   1. Open drip proof for general use.
   2. Totally enclosed for wet or exterior use.
   3. Explosion-proof for hazardous location use.

D. Electric Motors of ¾ HP rating and over, heavy duty, ball bearing, open (drip-proof), squirrel
cage induction type, normal starting torque 60 cycle service, 400 F continuous rating, and
shall conform in all respects to the latest applicable standard of NEMA and AIEE. Motors up
to ¾ HP rating shall have sleeve or ball bearing. Electric motors which are not housed
within equipment they serve, shall be stamped for Quiet-Operation. Motors shall be of an
Energy Efficient design meeting C.E.C., Title 24.

E. Motor starters and contactors except those in motor control centers shall be included in the
mechanical work.

PART 3 - EXECUTION

3.1 ELECTRICAL REQUIREMENTS

A. Provide working space around electrical equipment in compliance with the applicable Code
and all Safety Orders.

B. Coordinate the Mechanical Work with the Electrical Work to comply with the above. Furnish
and set in place all motors and duct or pipe installed controls.

C. Location of all new switches shall be verified with the architect or architect before
roughing-in. Furnish necessary control diagrams and instruction for the proper installation of
the controls.

D. Assume responsibility to insure that all motors are connected with flexible conduit per
Division 26 requirements.

E. Assume responsibility for the proper supervision and testing of the controls for sequence of
operation.
F. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers Association.

G. All equipment electrical characteristics shall be as noted on the drawings, or as specified. Verify before ordering any equipment.

H. Before permitting operation of any equipment which is furnished, installed or modified under this contract, review all wiring connections that pertain to mechanical equipment or work, and verify that these connections are correct.

I. Ascertain that the over-load protection devices installed are of the correct type, rating and setting to properly protect this equipment.

J. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize mechanical equipment wiring diagrams to coordinate with the electrical systems so that proper wiring of the equipment involved is affected.

END OF SECTION
SECTION 23 05 13.10
ADJUSTABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SEE SECTION 22 05 00

1.2 DESCRIPTION

A. This specification is to cover a complete Adjustable Frequency motor Drive (AFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. It is required that the drive manufacturer have an existing:
   1. Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.
   2. An independent service organization.

B. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers (IEEE)
   2. Underwriters laboratories
      a. UL508C
   3. National Electrical Manufacturer’s Association (NEMA)
      a. ICS 7.0, AC Adjustable Speed Drives
   4. IEC 16800 Parts 1 and 2

B. To ensure quality and minimize failures at the job site, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test. The drives shall be tested at the site with the motors that they shall be controlling.

C. A potential difference between the motor shaft and frame of greater than 3 volts shall not be allowed.

D. Qualifications:
   1. AFD’s and options shall be UL listed as a complete assembly. AFD’s that require the customer to supply external fuses for the AFD to be UL listed are not acceptable. The base AFD shall be UL listed for 100 KAIC without the need for input fuses.
   2. CE Mark – The AFD shall conform to the European Union Electro Magnetic Compatibility directive, a requirement for CE marking. The AFD shall meet product standard EN 61800-3 for the First Environment restricted level.
   3. Acceptable Manufactures
      a. ABB ACH Series, Baldor, Reliance, or equal.
4. AFD's that are manufactured by a third party and “brand labeled” shall not be acceptable.

5. The AFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering AFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user’s site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.

1.4 SUBMITTALS

A. Submittals shall include the following information:
   1. Outline dimensions, conduit entry locations and weight.
   2. Customer connection and power wiring diagrams.
   3. Complete technical product description include a complete list of options provided
   4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
      a. The AFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519. All AFD’s shall include a minimum of 5% impedance reactors, no exceptions.

PART 2 - PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES

A. The AFD package as specified herein shall be enclosed in a UL Listed Type 1 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The AFD tolerated voltage window shall allow the AFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

   1. Environmental operating conditions: 0 to 40°C continuous. AFD’s that can operate at 40°C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.

   2. Enclosure shall be rated UL type 1 and shall be UL listed as a plenum rated AFD. AFD’s without these ratings are not acceptable.

B. All AFD’s shall have the following standard features:

   1. All AFD’s shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple AFD’s.

   2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Hand” and “Auto” modes. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.
3. There shall be a built-in time clock in the AFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the AFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The AFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

4. The AFD’s shall utilize pre-programmed application macro’s specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The AFD shall have two user macros to allow the end-user to create and save custom settings.

5. The AFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the AFD from the wall or removal of circuit boards. The AFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.

6. The AFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

7. The AFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.

8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.

9. The AFD shall have integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. AFD’s with only one DC reactor shall add AC line reactors.

10. The input current rating of the AFD shall be no more than 3% greater than the output current rating. AFD’s with higher input current ratings require the upstream wiring, protection devices and source transformers to be oversized per NEC 430-2.

11. The AFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV’s (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

12. The AFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false under load condition.

13. If the input reference (4-20mA or 2-10V) is lost, the AFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the AFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to
signal this condition via a keypad warning, relay output and/or over the serial communication bus.

14. The AFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

C. All AFD’s to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the AFD from operating the load continuously at an unstable speed.

2. Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the AFD, using the microprocessor in the AFD for the closed loop control. The AFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the AFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.

3. Two (2) programmable analog inputs shall accept current or voltage signals.

4. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.

5. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as follows:

6. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications) the AFD shall provide a dry contact closure that will signal the damper to open (AFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an AFD digital input and allows AFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.

7. Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.

8. Seven (7) programmable preset speeds.

9. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
10. The AFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

11. The AFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual AFD temperature that allows the highest carrier frequency without de-rating the AFD or operating at high carrier frequency only at low speeds.

12. The AFD shall include password protection against parameter changes.

D. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:
   1. Start-up assistants.
   2. Parameter assistants
   3. Maintenance assistant
   4. Troubleshooting assistant

E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
   1. Output Frequency
   2. Motor Speed (RPM, %, or Engineering units)
   3. Motor Current
   4. Calculated Motor Torque
   5. Calculated Motor Power (kW)
   6. DC Bus Voltage
   7. Output Voltage

F. The AFD shall include a fireman’s override input. Upon receipt of a contact closure from the fireman’s control station, the AFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. “Override Mode” shall be displayed on the keypad. Upon removal of the override signal, the AFD shall resume normal operation.

G. Serial Communications
   1. The AFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2 bus, BACnet, and Siemens Building Technologies FLN. Optional protocols for LonWorks, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base AFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority. Use of non-certified protocols is not allowed.
   2. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt
hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the AFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote AFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the AFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

3. The AFD shall allow the DDC to control the drive’s digital and analog outputs via the serial interface. This control shall be independent of any AFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive’s digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive’s digital and analog inputs shall be capable of being monitored by the DDC system.

4. The AFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the AFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The AFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

H. EMI / RFI filters. All AFD’s shall include EMI/RFI filters. The onboard filters shall allow the AFD assemble to be CE Marked and the AFD shall meet product standard EN 61800-3 for the First Environment restricted level.

I. All AFD’s through 50HP shall be protected from input and output power miss-wiring. The AFD shall sense this condition and display an alarm on the keypad.

J. OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

1. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Motor overload protection and shall be provided in both drive and bypass modes.

2. The bypass tolerated voltage window shall allow the AFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum. The bypass shall incorporate circuitry that will allow the drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum. Wider voltage tolerance windows are acceptable, but the +30%, minus 35% is the minimum.

3. The Bypass shall be based on a microprocessor controlled system allowing for advanced control and operational items listed below.

4. No contactor chatter - The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the drive mode. Designs that will not allow input single phase operation in the drive mode are not acceptable. The drive and bypass contactors
shall be standard, off-the-shelf, 115 V coil contactors. Special, hard to source, 24 VDC contactor coils are not allowed.

5. The Bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the AFD has been removed from the system for repair / replacement.

6. Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.

7. Fused AFD only disconnect (service switch). Fast acting fuses exclusive to the AFD – fast acting fuses allow the AFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the AFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.

8. Serial communications – the bypass shall be capable of being monitored and/or controlled via serial communications. On-board communications protocols shall include Modbus; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet. Optional protocols such as LonWorks, DeviceNet, Ethernet IP (DeviceNet over Ethernet & Modbus TCP), and Profinet shall be available with the addition of an option card.

9. Serial communication capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, and bypass selected. The DDC system shall also be able to monitor if the motor is running in the AFD mode or bypass mode over serial communications. A minimum of 40 field parameters shall be capable of being monitored in the bypass mode.

10. The bypass communications shall allow control of the bypass’ digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass’ digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the bypass’ digital inputs shall be capable of being monitored by the DDC system.

11. The AFD and bypass shall include a “run permissive circuit” that will provide a normally open contact whenever a run command is provided (local, serial communications, or remote start command in AFD or bypass mode) if all safeties are meet. The AFD system (AFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the AFD system safety interlocks (fire detector, freeze Está, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve. This feature will also operate in Fireman’s override mode.

12. The microprocessor based bypass control shall allow for indication and protection from welded contactors or open contactors. This failed contactor operation shall be indicated on the Bypass LCD display as well as over the serial communications protocol.

13. The microprocessor based bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. This will allow VAV
boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

14. There shall be a keypad adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode. For example, the user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:
   a. Over current
   b. Over voltage
   c. Under voltage
   d. Loss of analog input

15. The drive / bypass shall provide single-phase output motor protection in both the AFD and bypass modes.

16. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode. The broken belt indication shall be programmable to be a system (drive or bypass) indication. The broken belt indication shall be programmable to cause a warning or a fault and system shutdown. The broken belt indication shall be indicated on the keypad display as well as be transmitted over the building automation protocol and / or a relay output contact closure.

17. The following operators shall be provided:
   a. Bypass Hand-Off-Auto
   b. Drive mode selector
   c. Bypass mode selector
   d. Bypass fault reset
   e. Bypass LDC display, 2 lines, for programming and status / fault / warning indications

18. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
   a. Power-on (Ready)
   b. Run enable
   c. Drive mode selected
   d. Bypass mode selected
   e. Drive running
   f. Bypass running
   g. Drive fault
   h. Bypass fault
   i. Bypass H-O-A mode
   j. Automatic transfer to bypass selected
   k. Safety open
   l. Damper opening
   m. Damper end-switch made
19. The on-board relay (form C) outputs from the bypass shall be programmable for any of the following indications. (Choose any five from the list below).
   a. System started
   b. System running
   c. Bypass override enabled
   d. Drive fault
   e. Bypass fault
   f. Bypass H-O-A position
   g. Bypass under load (broken belt)
   h. Overload
   i. Bypass selected
   j. Bypass run
   k. System started (damper opening)
   l. Bypass alarm
   m. Over temperature
   n. System under load (broken belt)

20. The digital inputs for the system shall accept 24V. The bypass shall incorporate internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others.

21. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (these may or may not be functional in Fireman's Override Mode). The remote start/stop contact shall operate in AFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs. The user shall be able to select the text to be displayed on the keypad when the safety opens. Example text display indications include “Firestat”, “Freezstat”, “Over pressure” and “Low pressure”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

22. Dedicated digital input that will transfer motor from AFD mode to bypass mode upon dry contact closure for Fireman's Override. Two modes of operation are required.
   a. One mode forces the motor to bypass operation and overrides both the AFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
   b. The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction). This mode shall allow custom user programming to not ignore certain Digital Inputs (Safeties) or single phase and other fault conditions.

23. Class 20 or 30 (selectable) electronic motor overload protection shall be included.

2.2 EQUIPMENT IDENTIFICATION

A. All equipment shall have a stainless steel identification tag pinned in place in a readily accessible location with the following information at a minimum (when applicable).
1. Manufacturer's name.
2. Manufacturer's model number.
3. Date of manufacture.
4. Serial number.
5. Code stamp.
6. Electrical power requirements.
7. Equipment name.
8. Equipment identification tag numbers.

PART 3 - EXECUTION

3.1 ADJUSTABLE FREQUENCY DRIVE START-UP SERVICE

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

B. The manufacturer shall provide start-up commissioning of the variable-frequency drive and its optional circuits by a factory-certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer’s site. Sales personnel and other agents who are not factory-certified technicians for drive field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for proper operation and installation of the VFD, its options and its interface wiring to the building automation system. As a minimum, this service shall include:

C. Verification of contractor wire terminations to the VFD and its optional circuitry.

D. Up to four hours of customer operator training on operation and service diagnostics at the time of the equipment commissioning. Give 48 hours notice before scheduling equipment commissioning.

E. Measurement for verification of proper operation on each of the following items:

F. Motor voltage and frequency. Verification of proper motor operation.

G. Control input for proper building automation system interface and control calibration.

H. Calibration check for the following set points (and adjustment as necessary): minimum speed, maximum speed, and acceleration and deceleration rates.

3.2 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the AFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

B. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the AFD, bypass and serial communication.
3.3 WARRANTY

A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

3.4 INSTALLATION:

A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.

B. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.

C. Examination

1. Contractor to verify that jobsite conditions for installation meet factory-recommended and code-required conditions for VFD installation prior to start-up. These shall include as minimum:
   a. Clearance spacing.
   b. Temperature, contamination, dust and moisture of the environment.
   c. Conduit installation of the motor wiring and power wiring separation.

2. The VFD is to be covered and protected from construction dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

3. The contractor shall provide written certification during startup that there is not a potential difference between the motor shaft and frame of greater than 3 volts and that premature bearing wear will not be caused by the VFD for a minimum period of 36 months.

3.5 ADJUSTING

A. Equipment Start-up: When installed and connected, the unit shall be inspected, checked, and approved as ready for operation by the contractor before unit is initially operated. The contractor shall then initiate and thoroughly check the unit operation, make or direct all adjustment necessary to place the unit in satisfactory operation, and certify in writing that the unit is properly installed, connected, and operating. The equipment shall not be placed in service until that certification is received. Also provide instruction of Owner's personnel on operation and maintenance after certification.

END OF SECTION
SECTION 23 05 16
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SEE SECTION 23 05 00

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Expansion Loops
   1. General
      a. Metallic Piping Systems: Metraflex Metraloop or equal.
         1) Flexible loops shall be designed to impart no thrust loads on the anchors.
         2) Loop shall consist of two flexible sections of hose a braid, two 90 degree elbows and a 180 degree return.
         3) Hose and braid: Series 300 Stainless Steel rated for 150 psi, 400°F
      c. Others as specified in other piping sections or shown on drawings.

B. Piping Flexible Connectors
   1. Metallic Piping Systems (Below 140°F): Garlock style, 204, General Rubber 1050 or equal. Double arch seamless chlorobutyl elastomer tube and cover meeting ASTM specifications D2000 Grade 2AA610AB.L13 rated for 150 psi, 250°F service. The body shall be reinforced with rectangular or round body rings and a minimum of six bias plies of polyester fabric. An acrylic coating shall be applied completely and uniformly to the cover. All expansion joints shall be rated for 140 psi, 26" vacuum at 250o F for sizes up to and including twelve inches in diameter. Provide 3/8" thick galvanized flat, not L shaped, backup rings and control rods with a rubber bushing to eliminate metal to metal contact to eliminate axial extension. All expansion joints shall be domestically manufactured. The manufacturer shall provide documentation utilizing oven aged and cold flexibility tests to verify elastomer capability.
   2. Metallic Piping System (140°F and above): Hyspan 5501R 3 ply 304 stainless steel bellows, Flexonics model TCS-R or equal. 304L Stainless Steel bellows rated for 150 psi, 750°F
   4. Others as specified in other piping sections or shown on drawings.

C. Piping Flexible Hose
   1. Flexible connections in refrigerant lines and other high temperature lines shall be stainless steel hose and braid with carbon steel fittings.
      a. Connectors two inches and diameter or less shall use male threaded nipples.
      b. Connectors greater than 2 inches in diameter shall be flanged.
      c. Hoses shall be suitable for operating temperatures up to 500o F.
d. All metal flexible connectors shall have a certified helium leak test and hydrotest to maximum rated system test pressure.

D. Expansion Compensators
   1. Metallic Piping Systems: Metraflex model HP
      a. Multi-ply stainless steel bellows rated for 150 psi, 400°F
   2. Others as specified in other piping sections or shown on drawings

PART 3 - EXECUTION

3.1 PIPING SYSTEMS

A. Install piping to allow for expansion, contraction, and structural settlement. Provide pipe guides and pipe anchors where required and shown on drawings. Contractor shall design all expansion / contraction systems per ASHRAE 2016 “HVAC Systems and Equipment Handbook”.

B. Expansion: Install piping with sufficient offsets, loops, and/or swing joints to allow for expansion and contraction. Anchor piping at equipment to restrain movement at those locations.

END OF SECTION
SECTION 23 05 19

METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SEE SECTION 23 05 00

PART 2 - PRODUCTS

2.1 NATURAL GAS FLOW METERS

A. Equimeter Model as scheduled on drawings or equal.

B. Unit shall be constructed of cast steel ANSI B 16.5 and shall be hydrostatically tested at 2 times the maximum rated working pressure. The meter shall be air leak tested to 1.1 times operating pressure. The meter shall operate over a temperature range of −200 to +165°F. The meter shall be rated to operate at 175 psig.

C. Provide direct reading, non-adjustable index corrected for pressure and temperature reading out in cubic feet, mounted in an aluminum index box. Also provide an electronic signal for connection to the EMS system that will provide accurate output of cubic feet corrected for pressure and temperature.

D. Water Meters

1. Manual Readout

   a. Cast bronze, magnetic drive, positive displacement, which meets the AWWA Standard C700-77. Neptune T-10 or equal.

   b. Readout shall be in cubic feet per hour or in GPM.

2.2 INSTRUMENTATION

A. Thermometers

1. Trerice, adjustable angle with 304 stainless steel stem, 303 stainless steel mounting, 302 stainless steel head; 3" diameter, 270 degree arc white face with black numerals; 1/2" N.P.T. Provide the following:

   a. Thermometers installed on insulated pipes shall have 2-1/2" adjustable extension neck with brass separable socket.

   b. Provide cap and chain where sockets only are shown.

   c. Normal reading shall be at midscale and range shall be selected accordingly.

   d. Install at supply and return of each piece of equipment and coil and where shown.

B. Pressure Gauges

1. Trerice, liquid filled pressure gauges with Pattern DP stainless steel drawn case; bronze rotary movement phosphor bronze bourden tube. Provide front adjustable recalibration and recalibrator; 2 ½" when installed 6' or below and 4" diameter above 6'; 270 degree arc white face with black numerals; 1/4" bottom or back connection as required. Range shall suit application or as shown on drawings, normal operation shall be mid-scale. Provide the following:
a. Type 24 gauge cock and pulsation damper
b. Brass pigtail siphon.

C. Insertion Fittings and Instruments
1. Peterson Engineering Company "Pete's Plug"; ¼" MPT solid brass fitting and cap with Nordel valve core for water and neoprene valve core (for air) to suit 1/8" diameter instrument probes.

PART 3 - EXECUTION

3.1 EXECUTION

A. Instrumentation
1. Install all instrumentation items in a location where they are readily viewable and serviceable.

B. Flow Measuring Devices
1. Install flow measuring devices in accordance with manufacturer's recommendations. Provide required minimum distances upstream and downstream of the installed device. Notify Engineer prior to installation if these minimum requirements cannot be met in the location shown on the drawings for device installation.

END OF SECTION
SECTION 23 05 23

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SEE SECTION 23 05 00

1.2 REFERENCES

A. Pipes and Tubes
   4. Copper Drainage Tube: ASTM B 306, Type DWV, drawn temper.

B. Fittings

C. Joining Materials
   1. Pipe Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   2. Solder Filler Metal: ASTM B 32, alloys to suit system requirements.
   3. Brazing Filler Metals: AWS A5.8, alloys to suit system requirements.
   4. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 2 - PRODUCTS

2.1 VALVES, UNIONS AND FLANGES

A. These include valves manually operated with hand wheel, levers or other handles.
1. Furnish valves with chain-wheel operators for mechanical room applications where valves are installed above 7'-0" from floor.

2. Furnish two tee handle operators for each size to suit all valves which are installed below grade in access boxes and which are not fitted with integral handles; hub end valves shall be used where required.

3. Valves on systems operating over 100 psi shall be rated for 150 lb. or higher as required.

4. Unions shall have the same pressure rating as pipe fittings.

5. Ball Valves:

B. Shut-off service

1. Sizes 1" and smaller: Nibco T-585-SU, 400 psi rated, threaded or sweat ends, full port, teflon seat, quarter turn handle with stops, two piece bronze body.

2. Sizes 1-1/4" to 2": Nibco 595 Y, 400 psi rated, two-piece bronze body, threaded or sweat ends, teflon seat, full port swing-out accessibility, removal.

C. Balancing/shut-off service (Flow Metering Device)

1. 300 psi, 250° F rating, Tour & Anderson.
   a. Sizes 1/2" to 2": Tour & Anderson Circuit Balancing Valve, Series 787 (STAD), shall be Y-Pattern design and all metal parts of nonferrous copper alloy; positive shut off EPDM no drip seat; hidden memory stop; threaded connections. Valve to have differential pressure read-out ports across valve seat area.
   b. Sizes 2 1/2" and larger: Tour & Anderson Circuit Balancing Valve Series 788 (STAF, flanged end) or Series 789 (STAG, grooved end), shall be Y-Pattern design with cast iron body all other metal parts of nonferrous copper alloy. The valves shall have eight, twelve, or sixteen 360-degree adjustment turns of the handle wheel with hidden memory feature to program the valve with tamper-proof balancing setting.

2. Provide portable-indicating meters encased in protective case, one for the 1/2" to 1 1/2", and one for the larger sizes. The meter shall readout in inches w.g. with ± 1.5% accuracy. Provide master charts reading out in gpm for each meter.

D. Butterfly Valves: Shut-off service.

1. 175 psi rating. Nibco LD2000, Keystone, DeZurik, or equal, extended neck one-piece cast iron body with lug ends, 416.S.S. shaft and bushings, EPDM seat, and aluminum/Bronze disc. (175 psig). Victaulic Vic-300 (steel) or Style 608 (copper) may be used in grooved piping systems. Other features as follows:

2. Sizes 2-1/2" to 4": Infinite position lever handle, adjustable stop, aluminum bronze disc, stainless steel shaft, and bushings.

3. Sizes 6" and larger: Enclosed manual rotary actuator with hand wheel, indicator and memory stops when used for balance service, and semi-cast aluminum bronze disc, stainless steel shaft, and bushings.

E. Check Valves: Back flow prevention service

1. Swing check, Class 125 Buna-N Disc, Nibco or equal.
   a. Sizes 2" and smaller: Fig. T-413; bronze body, threaded ends, plug type bonnet.
   b. Size 2-1/2 and larger: Fig.F-968; iron body brass mounted, flanged ends, bolted bonnet.
2. Non-slam check Type NS, Bell & Gossett, Nibco, or equal.
   a. Size 4" and larger: Rating Fig. W-960; 250 psi rated, wafer or flanged ends.
   b. Cast-iron body, bronze plug, seat and guide bushing, stainless steel helical spring.
   c. Flow area through valve shall exceed cross-sectional area of specified pipe size by no less than 10%.

3. Grooved fittings Non-slam check Type NS, Victaulic.
   a. 2-1/2" and larger: Rating pressure 300 psi, grooved ends.
   b. Ductile iron body, synthetic rubber coated disc, welded nickel seat, stainless steel shaft and spring.
   c. Flow area through valve shall exceed cross-sectional area of specified pipe size by no less than 10%.

F. Pressure Reducing Valve
   a. Sizes ½" – 3", Watts Model 223 or equal.
   b. Bronze body, sealed cage, removable disc holder to allow disc replacement. Rated for temperatures up to 160o F. Adjustable pressure range from 25 to 75 psig with 300-psig initial pressure.
   c. Provide with a separate strainer and built in bypass feature.

G. Pressure Relief Valve
   1. Sizes 3¼" – 2", Watts Series 174A or equal.
   2. Bronze body, pressure range 30 psi – 150 psi, ASME Section IV certified, raised seat, non-mechanical disc alignment, maximum temperature rating 250o F.

H. Boiler Relief Valves
   1. A.S.M.E. rated for service intended. Bell & Gossett No. 1050 or approved equal.

2.2 STRAINERS

A. Y-Type, Armstrong
   1. Sizes 2" and smaller: 250 psi bronze body, threaded or soldered ends, threaded screen retainer. monel screen with .045" perforations.
   2. Sizes 2 ½" and larger: 125 psi body, 125 lb. flanged or grooved ends, bolted screen retainer. monel screen with .045" perforations.

B. Basket Type: Sarco, No. 528 with bolted cover and stainless steel basket.

2.3 PIPING AUXILLARIES

A. Cold Water Make-up
   1. Pressure reducing valve connected through ball valve and check valve.

B. Air Vent Valves
   1. Petcock shall be Lunkenheimer #1178 with a knurled handle.
   2. Large air vents off of mains 8" and larger shall be IAC industrial high capacity type, Amtrol 720 or equal.
3. Automatic Air Vents: Watts FV-4M1, Armstrong, Hoffman, float type air vent complete with stamped brass body and cover and solid, non-metallic float Maximum rated working pressure and temperature shall be 150 psig and 240°F.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Valves and Strainers

1. All shutoff valves in chilled and heating hot water lines shall be ball valves, unless otherwise shown.

2. Provide valves and strainers of the same size as the pipe in which they are mounted unless specifically shown otherwise.

3. Furnish discs suitable for service intended.
   a. All valves shall be properly packed and lubricated.

4. Unions shall be placed adjacent to each threaded or soldered valve.

5. Connect valves and strainers in copper piping systems with solder-to-threaded brass adapters.

6. Provide valves with trim proper to the service on which they are applied.

7. Locate above-grade valves:
   a. With stems above the horizontal plane of the pipe unless above ceiling.
   b. With valve handles below the horizontal for ease of access when above ceiling.
   c. Within six feet of floor where possible and reasonable.
   d. Out from under equipment.
   e. Readily accessible with adequate clearance around operating wheel or lever handle.

8. Provide shut-off valves at all inlet connections of coils, and equipment; on multiple coil banks, provide shut-off valve at the inlet of each coil. On water systems in sizes 2 ½" and larger, butterfly valves shall be used for shut-off service in lieu of ball valves. Provide gear driven operators for all valves 6" and larger.

9. Provide balance valves at all outlet connections of coils, and equipment in hydronic systems; multiple coil banks, provide a balance valve at the outlet of each coil.

10. Fit each strainer with globe or ball type blow down valve sized to match blow down tapping in screen retainer; run discharge pipe to nearest floor drain or other appropriate discharge point as shown or directed.

END OF SECTION
PART 1 - GENERAL

1.1 SEE SECTION 23 05 00

1.2 SUBMITTALS

A. Submit proposed alternative methods of attachment for review and approval by the Engineer, prior to deviating from the requirements given below.

B. For all seismic bracing systems, submit structural calculations and details prepared and signed by the Contractors licensed engineer which include all resultant forces applied to the building structure. Do not over-stress building structure. The submittal data required does not require an analysis of the building structural numbers and their reaction to the loads of the piping. The submittal data needs to address attachment methods and shall include calculations indicating the forces that are applied to the building structure at the point of attachment. Calculations will be reviewed for compliance with design criteria, not for arithmetic.

PART 2 - PRODUCTS

2.1 PIPE SUPPORTS

A. All pipes within the outer casings shall be supported at not more than 10-foot intervals. These supports shall be designed to allow for continuous airflow and drainage of the conduit in place. The straight supports shall be designed to occupy not more than 10% of the annular air space. Supports shall be of the type where insulation thermally isolates the carrier pipe from the outer conduit. The surface of the insulation shall be protected at the support by a sleeve not less than 12 inches long, fitted with traverse and, where required, rotational arresters.

2.2 HANGERS AND SUPPORTS

A. Building Attachments: Powder-actuated-type, drive-pin attachments with pullout and shear capacities appropriate for supported loads and building materials, UL listing and FM approval for fire-protection systems. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Provide beam clamp retaining straps for all pipe supports where attached to steel beams.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pullout and shear capacities appropriate for supported loads and building materials.

C. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

D. B-Line, finish: Electro-Chromate or hot dipped galvanized.
   1. Individual: B3690, B3100 cleavis or B3110
      a. Use H-104 all thread rod.
b. Use B3110 for pipe subject to movement.


3. For insulated pipe - B3690 pipe hangers sized to allow pipe insulation to pass continuously through the hanger.
   a. Trapeze Supporting Rods: Diameter sufficient to support the load with a safety factor of 5.
   b. Isolators: 319CT or Trisolator.

PART 3 - EXECUTION

3.1 PIPING HANGERS AND SUPPORTS

A. General
   1. Miscellaneous: Provide all supports, anchors, concrete pads, grouting, bedding, bracing, vibration isolation, and accessories required for pumps and other equipment.
   2. Support all piping with appropriate manufactured devices as specified use no wire or makeshift device.
   3. The engineer prior to installation shall approve all hanger material.
   4. Size hanger rods, screws, bolts, nuts, etc., according to manufacturer’s recommendations. Size hangers to fit around bare pipe, isolator, or insulated pipe shield as appropriate.
   5. Use cadmium plated or galvanized hangers, attachments, rods, nuts, bolts and other accessories where exposed to weather. Hot dip galvanize all items which are not factory finished. Plating for hinged movements must be done at factory.
   6. Hanger rods with C-clamp type structural attachment shall be equipped with retaining straps.
   7. At each support on bare copper tubing or piping system, install an isolator; at each support point on insulated piping systems, install an insulated pipe shield.
   8. Burning, welding, cutting, or drilling on any structural member may only be done if approved by the structural engineer.
   9. No valve or piece of equipment shall be used to support the weight of any pipe.
   10. Provide a hanger close to the point of change of direction of pipe run in either horizontal or vertical plane.
   11. When hangers or supports do not come within one foot of a branch line fitting, install an additional hanger or support at the fitting.

B. Pipe Supports
   1. Horizontal Lines
      a. Suspend all horizontal pipes individually and not in contact with the structure except as specified below. Support each branch line with at least one hanger.

C. Parallel pipes may be supported on trapeze type hangers. Size trapeze hangers to support weight of piping plus a surcharge of 300 pounds. For three or more pipes use a size suitable for the load in accordance with manufacturers published load ratings. No deflection to exceed 1/180 of a span. Anchor rods securely to building structure.
3.2 LINES NEAR FLOOR

A. Support all piping near the floor individually by means of adjustable steel pipe stanchions with welded end plates properly secured to the pipe and to the floor. Alternate: Lines also near walls may be suspended as specified above for horizontal lines, from appropriately sized and mounted angle brackets.

B. Hanger Spacing Schedule:

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>1&quot; dia. Or under</th>
<th>1¼&quot; to 2&quot; dia</th>
<th>2½&quot; dia &amp; over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Pipe</td>
<td>8'-0&quot;</td>
<td>10'-0&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>Copper Tubing</td>
<td>6'-0&quot;</td>
<td>8'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>Support at 8' - 0&quot; intervals and on each side of and within 12&quot; of both sides of joint</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Rod Size:        | ¾"              | ½"            | 5/8"          | 5/8"          |
| Pipe Size        | (1/2" – 2")     | (2-1/2" – 5") | (6" – 8")     | (over 8")     |

END OF SECTION
PART 1 - GENERAL

1.1 SECTIONS INCLUDE

A. General: Refer to Section 23 05 00, Mechanical - General.
B. Work Included: Provide all ductwork and ductwork accessories, auxiliaries, and adjuncts for all and systems as specified or shown.
C. Work Described Elsewhere: HVAC piping, equipment, and controls are specified in other HVAC Sections.

1.2 RELATED SECTIONS
A. All Sections of Division 23.

1.3 SUBMITTALS
A. Air Balancing: Provide submittals for air balancing work as specified in Section 15600 HVAC General.

PART 2 - PRODUCTS

2.1 GENERAL:

A. The contractor shall provide all miscellaneous metal to bridge between structural beams to provide connection for duct supports. As an alternate ductwork may be supported from the roof deck if approved by the owner and structural engineer.

B. Rectangular Ducts (Horizontal):
   1. Up to 30" duct width: Two 1-1/8" wide 16 gauge galvanized steel straps bolted to opposite sides of duct and firmly secured to overhead construction. Each strap must also be turned and screwed to bottom of duct.
   2. 30" and greater duct width: Trapeze assembly comprised of Unistrut, Powerstrut, channel supported at each end by rod firmly secured to overhead construction; affix duct to channel with angle bracket on each side. Each strap must also be turned and screwed to bottom of duct.
      a. 30" to 72" duct width: Use P-1000 channel, size as necessary, 3/8" diameter rods.
      b. 72" to 84" duct width: Use P-1000 channel, size as necessary, 1/2" diameter rods.
      c. 84" and greater duct width: Use P-1001 channel, 1/2" diameter rods.

C. Round Ducts (Horizontal):
   1. Up to 40" in diameter: Two (2) 1 - 1/2" wide 18 gauge galvanized steel straps, firmly secured to overhead construction and extending around the entire perimeter of the duct and secured to the duct. Provide bracing to prevent duct sway as specified above for rectangular duct.
2. Ducts over 40" in diameter: All supports for round ductwork over 40" must be approved by the structural engineer.

D. Vertical Ducts:
1. Rectangular: Unistrut, Powerstrut, P-1000 channel riveted or bolted to side of duct and secured to the structure at each floor or other such level.
2. Round: Fabricate two-piece angle iron collar, rivet or bolt to duct, secured to structure per above.

PART 3 - EXECUTION

3.1 DUCTWORK SUPPORTS

A. Supports
1. Install ductwork in accordance with applicable details, SMACNA "Guidelines for Seismic Restraints of Mechanical Systems, 1991 ed." recommendations, manufacturer's recommendations, and best practice, coordinate all ductwork support connection with the Structural Engineer.
2. Install ducts rigidly, securely, and air tight.
4. Ducts shall be vibration isolated as described in 23 05 48.
5. Penetrations:
   a. Description: All penetrations of walls separating shall have a minimum clearance of 1/2-inch and a maximum clearance of 3/4 inch.
   b. Materials: A minimum 1.5 lbs/cu.ft. fiberglass insulations shall be used and a nonhardening caulking compound.
   c. Installation: The opening around the penetration shall be filled loosely with the fiberglass insulation. The opening is then to be sealed airtight with the non-hardening caulking compound. Pipes, ducts, etc., shall be supported on either side of the wall with supports to roof structure.
6. Support of rectangular metal ducts:
7. Support per SMACNA or current local Mechanical Code whichever is more stringent.
8. Support of round metal ducts:
   a. Support per SMACNA or current local Mechanical Code whichever is more stringent.

END OF SECTION
SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SEE SECTION 23 05 00

A. Furnish and install all systems, units, equipment, and parts to meet or exceed current applicable requirements for seismic resistance specified by codes, regulations, or agencies having jurisdiction. Include all supports, anchors, braces, and other restraining devices required. All seismic restraints and isolation shall meet seismic code requirements.

B. Design and installation of seismic bracing shall be per CBC Chapter 16.

1.2 QUALITY ASSURANCE

A. General: All isolators furnished under this Section for a given application shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the equipment.

B. Manufacturers must demonstrate to the satisfaction of the Engineer that the quality is equal to the equipment made by those manufacturers specifically named herein. Wherever possible, all materials and systems specified in this section shall be purchased from a single vibration isolation materials manufacturer to assure single responsibility for the performance of all isolation materials used.

C. Vibration and Noise: The completed installation must control vibration and noise to the specified limits. Systems equipment, or parts which vibrate or generate vibration unduly or which generate or emit undue noise while in operation shall: (1) be adjusted, repaired, or replaced as appropriate to obtain acceptable levels of vibration or noise, or (2) be supported on or fitted with suppression or absorption devices or means which effectively prevent the transmission of vibration or noise beyond the offending item.

1.3 SEISMIC RESISTANCE

A. Furnish and install all systems, units, equipment, and parts to meet or exceed current applicable requirements for seismic resistance specified by codes, regulations, or agencies having jurisdiction. Include all supports, anchors, braces and other restraining devices required. All seismic restraints will meet the following site specific seismic design criteria:

1. Seismic Design Category D, 2) Importance Factor, \( I_P = 1.0 \) except \( I_P = 1.5 \) for fire sprinklers; and 3) SDS = 1.64

2. Seismic restraints are the responsibility of the contractor.

B. Design of seismic bracing shall meet requirements of CBC Chapter 16A.

1.4 SUBMITTALS

A. Manufacturer's Data:

1. Provide materials lists, catalog data sheets, manufacturer's drawings and technical literature covering details of all equipment or items specified or shown on drawings.

2. For Metal Spring Isolators provide the following as a minimum:
2.1 GENERAL

A. Acceptable manufacturers of vibration and seismic control devices:
   1. Mason Industries or approved equal by the Engineer.

B. Elastomeric Isolation Pads (EIP):
   1. Acceptable manufacturers include but are not limited to the following:
      a. Mason Industries, Inc. – Type Super W Pad
   2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area. Acceptable manufacturers include but are not limited to the following:
      a. Mason Industries, Inc. – Type Super W Pad
   3. Size: Factory or field cut to match requirements of supported equipment.
   4. Verify availability of various pad materials and their properties with manufacturers.
   5. Pad Material: Oil and water resistant with elastomeric properties.
C. Housed Spring Isolators (HIS) Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
   1. Acceptable manufacturers include but are not limited to the following:
      a. Mason Industries, Inc. – Type C
      b. Or approved equal
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
      a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
      b. Top housing with attachment and leveling bolt.

D. Restrained Spring Isolators (RSI) Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
   1. Acceptable manufacturers include but are not limited to the following:
      a. Mason Industries, Inc. – Type SLR
      b. Or approved equal
   2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
      a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
      b. Top plate with threaded mounting holes.
      c. Internal leveling bolt that acts as blocking during installation.
   3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
   4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

E. Housed Restrained Spring Isolator (HRSI) Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
   1. Acceptable manufacturers include but are not limited to the following:
      a. Mason Industries, Inc. – Type SSLFH
      b. Or approved equal
2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Spring Hangers (SH) Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
   1. Acceptable manufacturers include but are not limited to the following:
      a. Mason Industries, Inc. - Type 30
      b. Or approved equal
   2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   8. Retain "Adjustable Vertical Stop" Subparagraph below if a vertical-limit stop is required.
   9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

G. Trisolators (T) Sheet metal sleeve with min 3/8" thick felt insert to be installed at attachment points of hangers or piping.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Semco.
      b. Elen.
      c. Emdor/Stoneman.
      d. or equivalent shop-fabricated device.
H. Restrained Spring Curb (RSC-1)
   1. Acceptable manufacturers include but are not limited to the following:
      a. Mason Industries, Inc. – Type RSC (OPA-0207)
      b. Or approved equal
   2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail
designed to resiliently support equipment.
   3. Upper Frame: Upper frame shall provide continuous and captive support for equipment.
   4. Lower Support Assembly: The lower support assembly shall be formed sheet metal
section containing adjustable and removable steel springs that support upper frame.
Springs to have a 1" deflection and 50% additional travel to solid. Spring diameters no
less than 0.8 of the spring height at rated load. All spring locations shall have access
ports with removable waterproof covers. The lower support assembly shall have a
means for attaching to building structure and a wood nailer for attaching roof materials
and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside
of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric
vibration isolation pads and shall have access ports, for level adjustment, with
removable waterproof covers at all isolator locations. Isolators shall be located so they
are accessible for adjustment at any time during the life of the installation without
interfering with the integrity of the roof.
   5. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
   6. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper
support frame, extending down past wood nailer of lower support assembly, and
counterflashed over roof materials.

I. Restrained Spring Curb (RSC-2)
   1. Acceptable manufacturers include but are not limited to the following:
      a. MicroMetl – Type CRBV (OPA-0070)
      b. Or approved equal
   2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail
designed to resiliently support equipment.
   3. Upper Frame: Upper frame shall provide continuous and captive support for equipment.
   4. Lower Support Assembly: The lower support assembly shall be formed sheet metal
section containing adjustable and removable steel springs that support upper frame.
Springs to have a 2" deflection and 50% additional travel to solid. Spring diameters no
less than 0.8 of the spring height at rated load. All spring locations shall have access
ports with removable waterproof covers. The lower support assembly shall have a
means for attaching to building structure and a wood nailer for attaching roof materials
and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside
of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric
vibration isolation pads and shall have access ports, for level adjustment, with
removable waterproof covers at all isolator locations. Isolators shall be located so they
are accessible for adjustment at any time during the life of the installation without
interfering with the integrity of the roof.
   5. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
   6. Water Seal: Curb shall be completely water proof and UV resistant materials used.
J. Provide piping and equipment isolation systems as specified or indicated on drawings.

K. Manufacturer shall be responsible for the proper selection of isolators to accomplish the specified minimum static deflection, based on weight distribution of equipment to be isolated.
   1. Vibration isolators selected shall have no less than 80 percent of the deflections given in Table I, Schedule.
   2. Contractor shall furnish a complete set of approved shop drawings of all mechanical and electrical equipment to receive vibration isolation devices to the vibration isolation materials manufacturer. The shop drawings to be furnished shall include operating weights of the equipment to be isolated and the distribution of weight at support points or the center of gravity location in three planes.

L. Manufacturer shall be responsible for selection of isolators to meet seismic codes.

M. Manufacturer shall supply information on operating heights and methods for assuring installation meets specifications.

N. The type of isolation, base and minimum static deflection shall be as required for each specific equipment application, but not less than that give in Table I, Vibration Isolation Schedule.

O. If vibration isolators with a deflection greater than the minimum specified are required to meet sound criteria or because of system dynamics, suitable isolation systems shall be submitted and approval received in writing prior to any installation work.

P. Coat all vibration isolation system exposed to moisture or an outdoor environment as follows:
   1. All steel parts to be hot dipped galvanized.
   2. All bolts to be cadmium plated.
   3. All springs to be cadmium plated and neoprene coated.
### 2.2 VIBRATION ISOLATION SCHEDULE

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Unit(s)</th>
<th>Design Deflection</th>
<th>Isolator</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC/AHU Units</td>
<td>AC-A2, AC-A3, AC-A4, AC-A5, AC-G1, AC-G2, AC-L1, AC-T1, AC-T2, AC-T3, AC-T4, AC-T5</td>
<td>2&quot;</td>
<td>RSC-2 – internal isolation to be disabled</td>
</tr>
<tr>
<td>IDEC Units</td>
<td>IDEC-L1 &amp; L2</td>
<td>3&quot;</td>
<td>RSC-1 – internal isolation to be disabled</td>
</tr>
<tr>
<td>Exhaust Fans (EF)</td>
<td>CFM &lt; 2000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Exhaust Fans (EF)</td>
<td>CFM &gt; 2000</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Heat Pumps Condensing Units</td>
<td></td>
<td></td>
<td>EIP</td>
</tr>
<tr>
<td>Fan Coil Units</td>
<td></td>
<td>1.0&quot;</td>
<td>SH</td>
</tr>
</tbody>
</table>

### GENERAL VIBRATION ISOLATION REQUIREMENTS

Incorporate a water hammer arrestor on connections to equipment using a quick closing valve.

Flexible conduits at connections to motors and other vibrating equipment.

Provide suitable flexible piping at connections to vibration isolated equipment such that vibration isolator efficiency is not reduced.

Use resilient elements at all support points where permitted. Where permitted, make no rigid connections between equipment, piping, and the building structure which would degrade the noise and vibration isolation system.

### PLUMBING LINES VIBRATION ISOLATION SCHEDULE

<table>
<thead>
<tr>
<th>Riser Support</th>
<th>0.06” deflection</th>
<th>Type EiP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Piping – first three support points</td>
<td>Deflection equal to connected equipment isolator</td>
<td>Type SH</td>
</tr>
<tr>
<td>Horizontal Piping – subsequent support points</td>
<td>Deflection equal to ½ that of connected equipment isolator – min 0.75”</td>
<td>Type SH</td>
</tr>
</tbody>
</table>

### 2.3 DESCRIPTION OF FLEXIBLE CONNECTORS

**A. Duct Flexible Connectors (DFC)**

2. Acceptable Suppliers: Ventfabrics, or equal.
B. Pipe Flexible Connectors (PFC)

   a. Connectors 2" diameter or less shall use threaded or flanged ends.
   b. Connectors greater than two inches diameter shall use floating galvanized steel flanges.

C. Flexible Pipe Hose: Stainless steel type (PFH)

1. Flexible connections in refrigerant and other high temperature lines shall be stainless steel braid and carbon steel fittings.
2. Hoses for thermal fluid must be suitable for 500°F operating temperature.
3. Connectors two inches diameter or less shall use male threaded nipples.
4. Connectors greater than two inches diameter shall be flanged.
5. All metal flexible connectors shall have a certified helium leak test and hydro test to the maximum rated system test pressure.
6. All flexible connectors shall be made in the USA.
7. Stainless steel hose assemblies with copper end fittings are not allowed.
   a. Model: BSS, FCSS, or equal

D. Seismic Pipe Hose: (SPH)

1. Seismic connectors for pipe runs in the “L” configuration:
   a. Flexible connectors shall be designed with sufficient live length on each flexible leg to provide a minimum of four (4) inches of movement in all directions.
   b. In addition to the flexible legs, connectors shall be constructed with a 90° elbow.
   c. Connectors shall have a minimum cycle life of 5000 cycles.
   d. Materials shall be type 321 stainless steel hose, 304 stainless steel braid with elbows and ends to match pipe material.
   e. Hoses for thermal fluid must be suitable for 500°F operating temperature.
   f. Acceptable Suppliers: Microflex, Hyspan, or equal

2. Straight pipe runs:
   a. Shall be of the Hyspan Tied Universal series 1511R with sufficient bellow design to provide a minimum of four (4) inches of movement in all directions
   b. In addition to the bellow, units shall be constructed with a center spool piece, tie rods, and 150# drilled flanges.
   c. Materials shall be type 304 stainless steel bellows, with carbon steel center spool piece, rods and flanges.
   d. Seismic universal tied expansion joints shall be anchored to isolate for required seismic motion. Anchors shall be properly sized to handle the loads created by thrust and spring forces of the expansion joint.
   e. Pressure rating 150 psi – 400 psi.
PART 3 - EXECUTION

3.1 GENERAL

A. Specific application of products shall be as delineated in this and other Sections of the Division.

B. Installation of all vibration isolation materials, spring and equipment bases specified in this section of the specifications shall be accomplished following the manufacturer’s written instructions.

C. Additional installation instructions may be specified in other Sections of the Division.

D. The isolation materials manufacturer shall be responsible for the proper selection of spring rates to accomplish the specified minimum static deflections, for all spring and pad type isolators, based on the weight distribution of equipment to be isolated.

E. The isolation materials manufacturer shall be responsible for the structural design of steel beam bases, to support mechanical equipment scheduled to receive a supplementary base.

3.2 INSTALLATION OF ISOLATORS, BASES AND SEISMIC RESTRAINTS

A. General

1. Isolators shall be installed and loaded per the requirements of the manufacturer except as otherwise indicated.

2. All vibration isolators for a single piece of equipment shall be installed to provide equal deflection and load.
   a. Adjust levelling devices as required to distribute loading uniformly onto isolators.
   b. Shim units as required where leveling devices cannot be used to distribute loading properly.
   c. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading and are not short-circuited by other contacts or bearing points.
   d. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.

3. Locate isolation hangers as near the overhead support structure as possible.

4. All connections to vibration isolated equipment shall be through flexible connections. This shall include all piping, electrical connections, fuel lines, structural elements, etc.

5. Equipment installed on metal spring isolators shall rock freely or move freely within limits of stop or seismic snubber restraints.

B. Hanger Spring Isolators

1. Hanger isolators shall be used on all main supply and return ducts supported from the deck above when within 50 feet of initial drop from the equipment.

2. Hanger isolators shall be used on all horizontal piping supported from the deck above when within 50 feet of initial drop from the equipment.

3. Hanger spring isolators shall be hung plumb to reduce chance of rod contacting spring housing. Check that spring or rod do not contact hanger housing after installation.

4. Attach seismic cables per SMACNA and CBC requirements.
5. After installation, confirm that unit can move or rock freely on spring.
6. Ensure that there is additional travel to full compression or to solid equal after spring is loaded.
7. Confirm the operating height is per manufacturer's submittal and that minimum static deflection is per specifications.

C. Spring Isolators
1. Vertical spring isolators shall be used on all roof top fans, pumps and floor-supported piping within 50 feet of the vibrating equipment to which it is connected.
2. All roof top unit fans shall include a thrust restraint spring at center line of fan.
   a. Spring shall be selected based on thrust load as calculated by vibration isolator manufacturer.
   b. Calculated thrust loads will be furnished with submittal.
3. Pipes and ducts in mechanical chases may be vibration isolated using seismically rated housed springs with a minimum deflection of 0.75 inches.
4. Guides and anchors shall be selected to provide restraint of horizontal pipe motion and be capable of supporting the full weight of the pipe.
5. In addition to submittal data requirements previously outlined, riser diagrams and calculations should be submitted for approval.
6. Calculations should show anticipated expansion and contraction at each support point, initial and final loads on the building structure and spring deflection changes.
7. Submittal data shall include certification that the piping system has been examined for excessive stresses and that none will exist in the design proposed.
8. Place spring under hole in equipment base and check to see if supports are badly off level. If so, shim mounting level before securing spring to base.
9. Adjust leveling bolts until the load distribution between springs is correct as denoted by whether spring is free and at operating height.
10. After installation, confirm that unit can move or rock freely on spring.
11. Ensure that there is additional travel to full compression or to solid after spring is loaded.
12. Confirm the operating height is per manufacturer's submittal and that minimum static deflection is per specifications.
13. Ensure that seismic system selected for the specific equipment or building element is installed per SMACNA and CBC requirements.

D. Spring Isolator Curb
1. All roof top ACU units shall be installed on combination roof curb/spring isolator.
2. Install spring isolator curbs strictly in conformance with the instructions provided by the manufacturer.
3. After removing cover plates, release spring lock downs.
4. Adjust leveling bolts until the load distribution between springs is correct as denoted by whether spring is free and at operating height.
5. After installation, confirm that unit can move or rock freely on spring.
E. Curb Isolator
1. Install kitchen or process exhaust fans on curb isolators.
2. Install spring curb isolators strictly in conformance with the instructions provided by the manufacturer.
3. Ensure fan curb is in place and secure prior to installing curb isolator.
4. Seismic restraint is to be installed per SMACNA and CBC requirements.

F. Neoprene Isolators
1. Install neoprene pads under boiler.
2. Install pads so that maximum stress level is not exceeded.
3. Ensure that no part of isolated equipment is in contact with the structure or any un-isolated component.

G. Composite Rubber Isolator
1. Install isolator at bearing points around both geared and gearless elevator equipment. This shall include the bearing points for the bedplate of the gearless drive, the frame of the motor generator and hoisting machine of the gearless machine.
2. Install isolator material under bolts and through bolt hole when securing equipment to structure. The isolator shall be separated from the bolt by a heavy flat washer that will not deform under the load.
3. The bolts shall be torqued per isolator manufacturer's guidelines and as required by the elevator equipment manufacturer.
4. Inspect that rubber isolator is not deflected to the point of excess deformation. Ensure that equipment does not contact the building structure.

H. Pipe Riser Isolators
1. All pipes and ducts in mechanical chases shall be resiliently supported.
2. Isolation manufacturer shall design isolation system to account for total motion of ducts and pipes.
   a. Guides and anchors shall be selected to provide restraint of horizontal pipe motion and be capable of supporting the full weight of the pipe.
   b. In addition to submittal data requirements previously outlined, riser diagrams and calculations should be submitted for approval.
   c. Calculations should show anticipated expansion and contraction at each support point, initial and final loads on the building structure and spring deflection changes.
   d. Submittal data shall include certification that the piping system has been examined for excessive stresses and that none will exist in the design proposed.
3. Install resilient supports/vibration isolators in strict conformance with manufacturer's recommendations.

I. Neoprene/Rubber Isolators for Pipe Hangers
1. All horizontal pipes not supported on a hanger isolator shall be supported using a neoprene/rubber isolator.
2. The isolators shall be installed per the manufacturer's recommendations if commercial product is used.

3. Contractor will ensure that after pipe is secured there is no discontinuity between pipe and hanger and pipe and structure.

4. Ensure that clamp around rubber/neoprene pad is not excessively tightened as this increases the stiffness of the isolator and short circuits the intended isolation quality of the hanger.

3.3 FLEXIBLE CONNECTOR INSTALLATION

A. Duct Flexible Connectors
   1. Provide at inlet and outlet of each supply and return fan and as shown on drawings.
   2. Allow one inch (1") minimum free space between metal collars each side of fabric.
   3. Connection shall be nominal six inches (6") wide with material taunt.

B. Pipe Flexible Connectors
   1. All pump suction and discharges shall be joined to the pipes using flexible connectors.
   2. Employ flexible connector at juncture with vibration isolated equipment.
   3. Install flexible connectors per manufacturers instructions.
   4. Flexible connections are to be used within one to three pipe diameters of the prime mover.
   5. Provide flexible pipe connection hose to suit the application. Shop drawings shall indicate specific applications.
   6. Flexible connectors shall be installed on the equipment side of the shutoff valves.

END OF SECTION
SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL
1.1 SEE SECTION 23 05 00

PART 2 - PRODUCTS
2.1 IDENTIFICATION

A. Equipment: Black Phenolic Plates engraved with 1/2" high white letters. The equipment shall be identified by the mechanical equipment schedule tag numbers shown on the plans (ie. AC-1, REF-1, ACCU-1). Coordinate identification numbers with electrical contractor to ensure that the disconnect switches and other electrical/mechanical equipment has consistent identification numbers.

B. Controls: Same as equipment above except 1/2" high letters.

2.2 PIPE IDENTIFICATION

A. Stencil and Painted pipe identification shall be provided.

B. Maximum spacing for identification shall be 10 feet.

C. Identification shall be provided per the following
   1. At both sides of floor or wall penetrations
   2. Adjacent to all valves and flanges
   3. Adjacent to all changes in direction
   4. To be visible from the point of normal approach

D. Indicate flow direction and type of fluid.

E. Color code shall be as follows:
   1. Heating Hot Water – Yellow Background with Black Lettering
   2. Heating Hot Water – Yellow Background with Black Lettering
   3. Natural Gas - Yellow Background with Black Lettering

F. Pipe Letter height shall be as follows:

<table>
<thead>
<tr>
<th>Outside Pipe Diameter Including Insulation</th>
<th>Minimum Length of Label</th>
<th>Minimum Height of Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>.75&quot; – 1.25&quot;</td>
<td>8&quot;</td>
<td>.5&quot;</td>
</tr>
<tr>
<td>1.5&quot; – 2&quot;</td>
<td>8&quot;</td>
<td>.75&quot;</td>
</tr>
<tr>
<td>2.5&quot; – 6&quot;</td>
<td>12&quot;</td>
<td>1.25&quot;</td>
</tr>
<tr>
<td>8&quot; – 10&quot;</td>
<td>24&quot;</td>
<td>2.5&quot;</td>
</tr>
<tr>
<td>Over 10&quot;</td>
<td>32&quot;</td>
<td>3.5&quot;</td>
</tr>
</tbody>
</table>
PART 3 - EXECUTION

3.1 EQUIPMENT AND CONTROL IDENTIFICATION
   A. Identify all equipment with permanently attached plates.
   B. Identify all controls and controllers except thermostats in finished areas.

3.2 IDENTIFICATION APPLICATIONS
   A. Piping and Valves
      1. Provide identifications for all valves. Provide tags with lettered inscriptions (not numbered).

END OF SECTION
PART 1 - GENERAL

1.1 SEE SECTION 23 05 00

A. Work Included: This Section describes balancing requirements for all phases of HVAC work. The work includes complete balancing, adjusting and testing of the air and hydronic equipment and systems.

1.2 QUALITY ASSURANCE

A. Testing and Balancing shall be performed in complete accordance with AABC National Standards for Field Measurement and Instrumentation only by an AABC or NEBB licensed contractor.

B. Work shall be performed by an independent test and balance agency that specializes in, and whose business is limited to testing and balancing of air conditioning systems.

C. Instruments used for testing and balancing of systems shall have been calibrated within a period of six (6) months and shall be checked for accuracy prior to start of work.

1.3 SUBMITTALS

A. Provide to the Owner and Contractor with four (4) copies of a balancing agenda prior to start of balancing work including:

1. General description of each air system with its associate equipment and operational cycles for winter heating, reheat, humidification, and cooling. Where different cycles are used for day and night time operation, describe separately.

2. A complete list of all flow and terminal measurements to be performed.

3. Agenda shall also include specific procedures for determining test parameters for flow. Specify type of instruments to be used, method of instrument application and air terminal correction factors for:

   a. Air terminal configuration.

   b. Flow direction (supply, return, or exhaust).

   c. Effective area application to each size and type of air terminal.

   d. Density corrections.

4. Furnish a copy of agenda to the engineer and Owner prior to start of work, including qualifications of key personnel assigned to the project.

B. Provide four (4) copies of final report, (two to the Owner and two to the Contractor) containing information outlined in AABC and in Part 3 - EXECUTION.

1.4 NOTIFICATION AND SCHEDULING

A. A pre-balance conference shall be held prior to start as scheduled by the Contractor. Attendees at the meeting shall include representatives of the Balancing Contractor, General Contractor, Mechanical Sub-contractor, Control Sub-contractor, and Owner.
B. The schedule for testing and balancing the HVAC system shall be established in coordination with the Balancing Contractor on a critical path network.

C. The Balancing Contractor is responsible for initiating this continuing coordination to determine schedule for final testing and balancing services.

1.5 COORDINATION WITH OTHER TRades

A. To bring the HVAC system into a state of readiness for testing, adjusting and balancing, the Mechanical Contractor shall perform the following:

1. Ensure that all splitters, extractor, volume, smoke and fire dampers are properly located and functional. Dampers serving requirements of smoke, minimum and maximum outside, return, relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.

2. Verify that all supply, return, exhaust, and grilles, registers, diffusers and terminal units are installed and operational.

3. Ensure that air handling or conditioning systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., are blanked and/or sealed to eliminate excessive bypass or leakage of air. All fans and systems (supply, return, relief, and exhaust) are operating and free of vibration.

PART 2 - PRODUCTS

2.1 INSTRUMENT AND TOOLS

A. Furnish all instrumentation and tools required to perform a complete air and water balance of all systems on this project.

2.2 FLOW METERING SYSTEM

A. Use flow metering systems specified and/or furnished to perform air and water balance.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate required locations of duct test openings and damper locations specified in other sections.

B. Coordinate work done by testing and balancing agency with work of other trades.

C. Plan Check and Review:

1. Review location and type of volume dampers inlet conditions to air terminals, valves and HVAC equipment.

2. Review location, type and size of balancing valve, flow metering stations and automatic control valves in the water flow system.

3. Review location of pressure sensors in the air and water distribution systems.

4. Review automatic control systems as they affect the test and balance procedure.
5. Review sheet metal and piping shop drawings to verify the installation of flow control devices.

D. Job Site Inspections

1. Check for necessary balancing hardware (dampers, flow meters, valves, pressure taps, thermometer wells, etc.) to determine if they are installed properly and readily accessible.

2. Identify and report possible restrictions in systems (closed smoke/fire dampers, fire dampers, long runs of flexible duct, poorly installed duct fittings).

3. The mechanical contractor shall make any changes in pulley, sheaves; supply new pulleys, sheaves, belts as required. In addition, the Mechanical Contractor to add dampers, etc. Necessary for correct balance at no additional cost to the Owner.

4. Check for necessary balancing hardware (dampers, flow meters, valves, pressure taps, thermometer wells, etc.) to determine if they are installed properly and readily accessible.

E. Identify and report possible restrictions in systems (closed smoke/fire dampers, fire dampers, long runs of flexible duct, poorly installed duct fittings).

3.2 TESTING

A. Testing equipment shall be furnished by the contractor; testing personnel shall be competent to conduct the tests.

B. Test all ductwork for excessive leakage and/or noise. Testing on any completed section of the ductwork must be made before installation of the finished ceiling or before the ductwork is furred in inaccessible spaces. Any leaks found must be properly repaired or joints remade and the section retested until tight. Any leaks which cause an objectionable noise must be repaired, regardless of the amount of leakage.

C. Should any piece of an apparatus or any material or work fail in any of the tests, it shall be immediately removed and replaced by new material, and portion of the work replaced shall again be tested by Contractor at his own expense.

D. AIR BALANCE

1. Changes, additions and modifications to dampers, pulleys and/or drive belts and other equipment necessary for proper air balance shall be provided by the Mechanical Contractor at no additional cost to the Owner.

2. The Mechanical Contractor shall retain the services of an independent certified test and balance agency to provide a complete air balance. All work shall be done by using instruments certified accurate to limits used in standard practice for testing and balancing of air distribution for heating-cooling systems.

3. Study design specifications and engineering drawings and prepare schedule to physically inspect mechanical equipment for air distribution systems to be tested and balanced.

4. Prepare test and balancing schedule, test record forms and necessary technical information about the air distribution systems for installed heating-cooling equipment, and fan systems, for complete total air balance.
5. Recommend adjustments and/or corrections to mechanical equipment and air distribution systems that are necessary for proper balancing of air handling systems.

6. Upon completion of the air handling system, the Air Balance Agency shall complete tests, analysis and balance of the air handling systems for heating-cooling equipment. The Air-Balance Agency then shall submit four copies of balance report to the Mechanical Contractor for forwarding to the Architect for evaluation and approval.

E. AIR BALANCE INFORMATION SHALL INCLUDE THE FOLLOWING

1. Design specifications of air handling equipment
   a. CFM
   b. Static Pressure
   c. % of Outside Air
   d. Fan Motor HP
   e. Fan Motor BHP
   f. Fan RPM

2. Installed equipment data
   a. Manufacturer
   b. Identifying Data

3. Balancing test data
   a. Fan Speed
   b. Fan Operating amperes
   c. Fan Operating BHP
   d. Fan Duct sizes
   e. Air Velocity (avg.)
   f. Total CFM
   g. Static Pressures
   h. Design Specifications of grilles and/or diffusers
   i. Manufacturer No. and Data
   j. FPM
   k. CFM

4. Installed equipment data
   a. Manufacturer No. and Data
   b. Location

5. Balancing test data
   a. FPM
   b. CFM

F. All outlets shall be set for the air pattern shown on plans.

G. Supply and return air dampers shall be set for design CFM, on heating and cooling cycle.
H. Test and balance shall correct for air density at 6000 ft. elevation and above.

3.3 WATER BALANCE

A. Hydronic System Balancing
   1. Calibration and testing of Hydronic system in conformance with AABC recommendations.
   2. Complete air balance prior to Hydronic system balancing.

B. Automatic control valve shall be set for full flow conditions during balancing procedures.
   1. Set pumps to design GPM quantities.
   2. Upon completion of flow ratings and coil adjustments, mark all settings and record all data.
   3. Recorded data shall include:
      a. Inlet and leaving temperatures at all coils and heating and cooling equipment.
      b. Pressure drop at each coil including coil bypass.
      c. Pump operating suction and discharge pressure and final total dynamic pump head.
      d. Rated and actual running amperage of pump motors.
   4. Venturis and calibrated orifices with portable or permanent flow meters shall be used to balance the water flows. When above equipment is not installed, obtain water flow balance by measurements of temperature differential across the various coils or elements.
   5. Automatic control valve shall be set for full flow conditions during balancing procedures.

C. Motor and Starters
   1. Measure the ampere reading of each motor input after final adjustments have been made. Measure the ampere reading of each electrical heater input after final adjustments have been made.
   2. Tabulate magnetic starters size, type and manufacturer with heater strip size and type for starters not in motor control centers.

3.4 OWNERS INSTRUCTION

A. Review the installation of all equipment and controls with the Owner after all systems are operating automatically. Instruct the Owner in the adjustment of all control and equipment devices. Allow a minimum of 4 hours for this instruction.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. See 23 05 00

1.2 SECTIONS INCLUDE
A. This Section describes insulation materials, methods, and applications for HVAC Mechanical Work, Special or specific details, applications, features, or methods may be described in work descriptions Sections or on the drawings.

1.3 REFERENCES
A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:
   1. American Society for Testing of Materials Specifications:
      b. ASTM C 585, "Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)"
      c. ASTM C 1136, "Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation"

1.4 SYSTEM PERFORMANCE

B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of applicable building codes when tested in composite form per one of the following nominally equivalent test methods:
   1. American Society for Testing of Materials   ASTM E 84
   2. Underwriters' Laboratories, Inc.  UL 723, CAN/ULC-S102-M88

C. Molded pipe insulation shall be manufactured to meet ASTM C 585 for sizes required in the particular system.

D. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547.

1.5 QUALITY ASSURANCE
A. Qualifications of Installers: only a licensed firm employing installers specifically skilled and experienced in applying insulation to piping shall do Insulation work.
B. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in above.

C. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

D. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

E. Codes and Standards:
   2. National Fire Protection Association - 90A.

1.6 DELIVERY AND STORAGE OF MATERIALS

A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way.

C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the contractor is able to demonstrate that wet insulation when fully dried out (either before installation or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance.

PART 2 - PRODUCTS

2.1 DUCT INSULATION – SEE 23 07 13

2.2 HVAC EQUIPMENT INSULATION – SEE 23 07 16

2.3 HVAC PIPING INSULATION – SEE 23 07 19

PART 3 - EXECUTION

3.1 APPLICATION / INSTALLATION

A. Use the types and thickness of insulation specified in work description Sections.

B. Apply insulations in accordance with the manufacturer's recommendations and with instructions specified herein or noted on the drawings.

C. Install insulations only after the systems, items, and equipment have been installed and tested, inspected, and accepted. Exceptions: Slip-on piping insulation and equipment insulations installed at the factory.
D. Fit insulation snugly to the item being insulated; butt all joints tightly with no voids, spaces, or thin spots.

E. Seal all joints completely; where sealing tape is used, center the tape over the joint.

F. Except where specified or necessary, do not use staples or fasteners which penetrate vapor barrier jackets or covers on cold systems or equipment; where such penetrating fasteners are used, seal each penetration completely to maintain the vapor barrier integrity. All penetrations of the ASJ and exposed ends of insulation shall be sealed with vapor barrier mastic. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

G. Use adhesives, mastics, cements, sealants, and finishes undiluted unless specifically directed otherwise; apply per manufacturer's directions.

H. Install outdoor jacketing or other specified weather proofing or finishing on all insulations outdoors.

I. Install all indoor exposed insulation with extra care and finish neatly.

J. Follow specified methods of installation unless alternative methods are submitted and approved.

3.2 FINISHING

A. Finishes and Protection:
   1. Insure that the exterior finish of all insulation is applied and complete as specified
   2. Make ready for painting or painted to match existing including color where specified for paint.
   3. Install all metal jackets or protective sheathing where specified.

B. Repair, Touchup: Properly repair and touchup all dents, rips, tears, or other damage inflicted on jackets or exterior surfaces of insulation. Breaks or punctures in the vapor barrier of external insulation will not be accepted and must be repaired prior to project acceptance.

END OF SECTION
PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. See Section 23 07 00

B. A continuous, intact vapor barrier is critical for ducts.

C. All insulation material shall have a mold, humidity, and erosion resistant face that has met the requirements of CMC Table 1701.

D. Insulation applied to the exterior surface of ducts located in buildings shall have a flame spread of no more than 25 and a smoke developed rating of not more than 50.

E. Insulate all above grade ductwork unless otherwise shown on the drawings or specified in Section 23 31 16 METAL DUCT.

PART 2 - PRODUCTS

2.1 ID-1 FLEXIBLE BLANKET/VAPOR BARRIER FACED:

A. Glass fiber reinforced Kraft/aluminum foil faced flexible blanket of 1.5 PCF nominal density resin bonded fibrous glass, have a installed thermal conductivity k factor of 0.25 at 75°F.; suitable for direct application and service on cold and dual temperature ductwork.

B. Supply FSK jacket with a permeance of 0.02 or less

C. Fiberglass ED-100 with all service facing, Certainteed Type 1001 Universal with Type IV facing, Schuller Manville Microlite with FSKL facing.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Supply Air Ducts indoors/concealed / (standard temperature)
   1. Use System ID-1 (Flexible Blanket / Vapor Barrier Faced
      a. 1.5" thickness for all sizes
      b. Applies to all cross sections (i.e. rectangular, circular, etc.)

B. Return Air Ducts indoors/concealed
   1. Use System ID-1 (Flexible Blanket / Vapor Barrier Faced
      a. 1 ½" thickness for all sizes
      b. Applies to all cross sections (i.e. rectangular, circular, etc.)

C. Do not externally insulate the following unless otherwise shown on the drawings or specified:
   1. Lined ductwork (indoors).
2. Above grade ducts conducting exhaust air or ventilating air (not heated or cooled and used for fresh air supply) unless otherwise noted.

3. Exposed ducts located in conditioned space.

3.2 INSTALLATION FLEXIBLE BLANKET/VAPOR BARRIER FACED

A. Install on supply and return ductwork so that condensation will not occur.

B. Wrap around ducts, butt all joints. Secure with 3" (minimum) width tape at 18" (maximum) intervals along the duct; tape may be of the same material as the insulation facing with a pressure sensitive adhesive on one side or may be Hardcast DT490-C mineral impregnated woven synthetic fiber using Hardcast FTA-20 roller. In addition, on rectangular and cross section ducts, secure to the flat bottoms more than 18" wide with SticKlip fasteners only with 1 1/2" diameter washers at 16" centers both ways; one centered longitudinal row is sufficient for ducts up to 36" flat bottom width.

C. Seal all seams and joints with 3" (minimum) width tape centered along the edge of the lap; tape shall be as specified above.

D. Seal all fastener penetrations with 3" x 3" (minimum) tape centered over the washer; tape shall be as specified above.

E. Where strap type duct supports penetrate the insulation, slit the insulation and facing, fit around the straps, and seal with tape as specified above; tape shall be of size to suit the situation and be applied in the number of layers necessary to obtain complete sealing.

F. For low temperature air ductwork, insulate the straps a minimum of 4 inches from any point of contact with the duct.

G. At trapeze or similar type duct supports, insert a 12" wide strip of Armaflex insulation, 1/2" thick between duct bottom and the supporting member across and 6" beyond both ends of the bearing surface. Lap ducts insulation over this insert and seal the same as other lapped seams.

H. Insulate all flexible duct connectors to the same thickness as adjacent duct insulation.

I. Continue insulation on terminal unit inlets to cover the entire inlet collar.

J. Insulate over all duct access doors with the same thickness as adjacent duct insulation. Provide removable insulation piece with an outer label on the insulation identifying the type of door.

END OF SECTION
SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. A continuous, intact vapor barrier is critical for all pipes conveying fluids at temperatures less than 75° F.

B. All insulation material shall have a mold, humidity, and erosion resistant face that has met the requirements of CMC Table 1701.

C. Insulation applied to the exterior surface of pipes located in buildings shall have a flame spread of no more than 25 and a smoke developed rating of not more than 50.

D. All requirements of Section 23 07 00 apply to this section.

PART 2 - PRODUCTS

2.1 IP-1 RIGID MOLDED SECTIONAL.INDOOR CONCEALED JACKET

A. Regular shape (straight run)

1. Molded sectional, factory fabricated of heavy density resin bonded fibrous glass, with integral factory applied all service jacket of Kraft paper/aluminum foil/glass fiber reinforcement.7

2. Insulation shall have a thermal conductivity k factor of 0.23 at 75° F. mean temperature and be suitable for direct application and service on piping having operating surface temperatures of –60 degrees to 450 degrees F.

3. Jacket shall:
   a. Extend 1 ½" (minimum) along one edge of longitudinal joint to form a sealing lap which shall be faced inside with a paper protected pressure sensitive adhesive;
   b. Have a permanence rating of 0.02 perm/in. and a Beach puncture resistance of 50 units;
   c. Have an exterior suitable for painting with latex or water base paint.

4. All insulation shall have composite (insulation, jacket, tape seal and adhesive used to adhere jacket to the insulation) Fire and Smoke Hazard ratings as tested under procedure ASTM E-84, NFPA 255 and UL 723, not exceeding Flame Spread of 25 and a Smoke Developed of 50. PVC fitting covers and accessories, such as adhesives, mastics, cements and cloth for fittings shall have the same component ratings.

5. Paper laminate jackets shall be permanently flame and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity.

6. Fiberglass Schuler-Manville Micro-Lok, or equal.

B. Irregular shape (fittings, flanges, valves, etc.)

1. Fibrous glass of same density, thickness, and other properties or characteristics as the adjacent regular shape insulation either pre-molded or field forged to fit the item being insulated. The pre-molded insulation shall be provided with weather protection cover.
2.2 IP-2 RIGID MOLDED SECTIONAL/OUTDOOR JACKET

A. Regular shape (straight run)

1. Molded sectional, factory fabricated of heavy density resin bonded fibrous glass, with integral factory applied all service jacket of Kraft paper/aluminum foil/glass fiber reinforcement.

2. Insulation shall have a thermal conductivity k factor of 0.23 at 75 degrees F; mean temperature and be suitable for direct application and service on piping having operating surface temperatures of –60 degrees to 450 degrees F.

3. Jacket:


   b. Irregular shapes:

      1) Surefit Aluminum Pipe Fitting Covers for pipes up to 6".

      2) Mitered aluminum sheet matching straight run jacketing for pipes over 6".

   c. Alternative jacketing: Schuler-Manville Type ML, metal jacketing system.

4. All insulation shall have composite (insulation, jacket, tape seal and adhesive used to adhere jacket to the insulation) Fire and Smoke Hazard ratings as tested under procedure ASTM E-84, NFPA 255 and UL 723, not exceeding Flame Spread of 25 and a Smoke Developed of 50. PVC fitting covers and accessories, such as adhesives, mastics, cements and cloth for fittings shall have the same component ratings.

5. Paper laminate jackets shall be permanently flame and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity.

6. Fiberglass Schuler-Manville Micro-Lok, or equal.

B. Irregular shape (fittings, flanges, valves, etc.)

1. Fibrous glass of same density, thickness, and other properties or characteristics as the adjacent regular shape insulation, either pre-molded or field forged to fit the item being insulated. The pre-molded insulation shall be provided with weather protection cover.

2.3 IP-3 ELASTOMERIC FOAM

A. Insulation shall be Elastomeric Foam Insulation. Insulation should have a maximum service temperature of 210o F, a minimum service temperature of –40 degrees F., and a "K" factor of .28 at 75 degrees F. The flame spread of the insulation shall be 25 or less, and smoke density shall be 50 or less when tested in accordance with ASTM E84.

B. Provide U.V. protective coating for all outdoor applications similar to Fosters 30-64 coating.

C. Rubatex R-180-FS/R-1800-FS, Armstrong Armaflex or equal

2.4 IP-4 CLOSED CELL POLYOLEFIN

A. Closed cell flexible plastic foam insulation should have a "k" factor of 0.27 or less at 75 degrees F and water vapor permeability of .2 perm-inch or less. The manufacturer shall warrant the insulation to be able to be directly buried underground without any protective jacket.

C. Provide U.V. protective coating for all outdoor applications

D. IMCOA Imcolock or equal.

2.5 IP-5 RIGID MOLDED SECTIONAL/INDOOR EXPOSED JACKET

A. Regular shape (straight run)

B. Molded sectional, factory fabricated of heavy density resin bonded fibrous glass, with integral factory applied all service jacket of Kraft paper/aluminum foil/glass fiber reinforcement.

C. Insulation shall have a thermal conductivity k factor of 0.23 at 75 degrees F. mean temperature and be suitable for direct application and service on piping having operating surface temperatures of −60 degrees to 450 degrees F.

1. Jacket:
   a. Straight runs: PVC fitting covers with vapor barrier.
   b. Irregular shapes:
      1) Amerisafe, factory molded aluminum covers, or
      2) Mitered aluminum sheet matching straight run jacketing; or
   c. Alternative jacketing: Schuler-Manville Type ML, metal jacketing system.

2. All insulation shall have composite (insulation, jacket, tape seal and adhesive used to adhere jacket to the insulation) Fire and Smoke Hazard ratings as tested under procedure ASTM E-84, NFPA 255 and UL 723, not exceeding Flame Spread of 25 and a Smoke Developed of 50. PVC fitting covers and accessories, such as adhesives, mastics, cements and cloth for fittings shall have the same component ratings.

3. Paper laminate jackets shall be permanently flame and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity.

4. Fiberglass Schuler-Manville Micro-Lok, or equal.

D. Irregular shape (fittings, flanges, valves, etc.)

1. Fibrous glass of same density, thickness, and other properties or characteristics as the adjacent regular shape insulation, either pre-molded or field forged to fit the item being insulated. The pre-molded insulation shall be provided with PVC protection cover.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS
NOTE: Where multiple systems are listed, contractor has the option to choose.

A. Heating (Hydronic HWS & HWR) water piping above grade/outdoors:
   1. Use System IP-2. (Rigid Molded Sectional/Outdoor Jacket)
      a. 2" thickness for all sizes
B. Heating (Hydronic HWS & HWR) water piping above grade/indoors concealed:
   1. Use System IP-1. (Rigid Molded Sectional/Indoor Concealed Jacket) with vapor barrier.
      a. 1" thickness for pipes smaller than 1" diameter
      b. 1 1/2" thickness for sizes 1" through 8" and 2" for all larger piping.

C. Heating (Hydronic HWS & HWR) water piping above grade/indoors exposed:
   1. All Piping located between Finished Floor to ten (10) feet above finished floor.
      a. Use System IP-5. (Rigid Molded Sectional/Indoor Exposed Jacket) with vapor barrier.
         1) 1" thickness for pipes smaller than 1" diameter
         2) 1 1/2" thickness for sizes 1" through 8" and 2" for all larger piping.
   2. All Piping located higher than ten (10) feet above finished floor.
      a. Use System IP-1. (Rigid Molded Sectional/Indoor Concealed Jacket) with vapor barrier.
         1) 1" thickness for pipes smaller than 1" diameter
         2) 1 1/2" thickness for sizes 1" through 8" and 2" for all larger piping.

D. Condensate (CD) water piping above grade/indoors:
      a. 3/4" thickness for all sizes
   2. Use System IP-4. (Closed Cell Polyolefin).
      a. 3/8" thickness for all sizes
   3. Use System IP-1. (Rigid Molded Sectional/Indoor Jacket) with vapor barrier.
      a. 3/4" thickness for all sizes

E. Refrigerant (RS) – Suction piping above grade/indoors
   1. Use System IP-3 (Elastomeric Foam)
      a. 3/4" thickness for all sizes

F. Refrigerant (RS) – Suction piping above grade/outdoors
   1. Use System IP-3 (Elastomeric Foam)
      a. 3/4" thickness with U.V. protection for all sizes

G. Refrigerant (HG) – Hot gas piping above grade/indoors
   1. Use System IP-3 (Elastomeric Foam)
      a. 3/4" thickness for all sizes

H. Refrigerant (HG) – Hot gas piping above grade/outdoors
   1. Use System IP-3 (Elastomeric Foam)
      a. 3/4" thickness with U.V. protection for all sizes
3.2 INSTALLATION

A. Unless specifically excluded herein or on the drawings, insulate all parts of hot and chilled water piping systems, steam piping, and condensate drains including fittings, flanges, valves, and pipe-mounted devices, except do not cover nameplates on devices.

B. Install insulation in removable sections over unions, flanges, and line components or devices requiring periodic maintenance.

C. Install insulation butted tightly to transitions such as insulated pipe shields, insulated pipe sleeves, equipment connections, etc.

D. Treat equipment face piping as follows:
   1. Where not subject to condensation (hot systems) terminate insulation at the outlet side of the equipment shut-off valve, leaving the face piping un-insulated, 24" max, unless noted otherwise, except where exposed to outdoors.

E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.

F. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable sealant to maintain vapor barrier integrity.

G. Rigid Molded Sectional/Jacketed:
   1. Comply with applicable general instructions above.
   2. Apply to all hot water and chilled water piping (except where specified or noted otherwise) installed above grade indoors and outdoors, concealed or exposed.
   3. Seal all transverse joints (except at PVC fitting jackets) with circumferentially applied 3" (minimum) width tape of same material as the jacket, faced with the same adhesive as the longitudinal lap, or seal with Hardcast 4" wide Type DT490-C mineral impregnated woven fiber tape (synthetic fiber indoors, cotton fiber outdoors) using Hardcast FTA-20 activator/adhesive applied by brush or roller. Seal transverse joints at PVC fittings jackets with color matching PVC tape and vapor barrier mastic adhesive.
   4. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of fiberglass pipe insulation, blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings.
   5. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low-density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough-cut ends shall be coated with suitable weather or vapor resistant mastic as dictated by the system location and service.
   6. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.
7. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems shall be sealed with caulking to allow free movement of the stem but provide a seal against moisture incursion.

8. Fit insulation terminations with Zestion, Snap Form, end cap jackets, or seal with Hardcast tape as specified above for joints.

9. On all piping (except equipment face piping) installed outdoors, install outdoor jacketing. Install aluminum sheet jacket with all joints turned down at 45° below horizontal; secure in place with non-corroding bands and/or blind rivets (do not puncture vapor barrier insulation jacket). On equipment face piping (including equipment shut-off valve) coat the insulation with %" thick Fosters 30-80 or Childers CP-38 outdoor vapor barrier coating reinforced with fosters Mast a Fab or Childers Chil Glas #10 and finished with two (2) coats of aluminum paint.

10. Penetrations
   a. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.

H. Closed Cell Polyolefin:
   1. Install pre slit, pre-glued closed cell polyolefin foam pipe insulation as per manufacturer's recommendations. Seal all joints and seams with Fuse-Seal Gun or with Armstrong 520 adhesive or equal in accordance with manufacturer's written instructions. Fabricate fitting covers from polyolefin foam insulation using same procedure.

END OF SECTION
SECTION 23 08 00

COMMISSIONING OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. The General Conditions, Supplementary Conditions and Division 01 are fully applicable to this Section, as if repeated herein.

1.2. RELATED WORK SPECIFIED ELSEWHERE

A. Division 01, Section 01 91 13, General Commissioning Requirements

B. All Division 23 Sections.

1.3. REFERENCES

A. USGBC:

1. LEED v4.0 Reference Guide for Building Design and Construction:
   a. Energy and Atmosphere Prerequisite: Fundamental Commissioning and Verification.

B. California Energy Commission:

1. Title 24, Part 6, 2016, Building Energy Efficiency Standards, Section 10-103 and Section 120.8-Building Commissioning

C. ASHRAE:

1. ASHRAE Guideline 0-2013: The Commissioning Process

2. ASHRAE Guideline 1.1-2007 HVAC&R Technical Requirements for the Commissioning Process

1.4. DEFINITIONS

A. Basis of Design (BOD): The documentation of design criteria and assumptions for systems, components, and methods chosen to meet the Owner's Project Requirements and applicable regulatory requirements, standards, and guidelines. The document includes narrative descriptions of the systems to be commissioned. The BOD is prepared by the Design Professionals.

B. Building Automation System (BAS): The automated building system providing control and user interaction with select building systems, such as the HVAC, domestic hot water and lighting systems. Also, often referred to as building management system (BMS), energy management system (EMS), or an energy management and control system (EMCS).

C. Commissioning (Cx): A quality-focused process to verify and document that building systems are installed and perform as intended per the OPR, BOD and design documents.

D. Commissioning Authority (CxA): An independent agent hired directly by the Owner and not otherwise associated with the Design Professionals or the General Contractor. The CxA is the authority on commissioning results and other commissioning program elements completion,
and assists the General Contractor with coordinating commissioning activities and witnesses the activities on behalf of the Owner.

E. Commissioning Issue: A condition that affects, prevents or inhibits commissioning, and must be resolved to complete the commissioning process.

F. Commissioning Issues & Recommendations Log (Cx Log): A log maintained by the CxA listing and describing all Cx issues and recommendations documented during the commissioning process, including providing the status, recommended action, contractor updates and resolution, and associated dates. All Cx issues require action, correction and closure.

G. Commissioning Report (Cx Report): The final report issued at the conclusion of the commissioning process. The report will include an executive summary abbreviating the outcome of the commissioning process and identifying all outstanding issues. The report also contains all commissioning documentation collected throughout all phases of the project.

H. Commissioning Plan (Cx Plan): A document that outlines the organization, coordination, and requirements of the commissioning process in more detail and contains project specific commissioning forms.

I. General Contractor (GC): The contractor directly contracted to the Owner with overall responsibility for the project and all commissioning activities described herein.

J. Commissioning Coordinator (CxC): Individual within the GC firm who plans, schedules, directs and coordinates all the Trade Subcontractor’s commissioning activities, and serves as the CxA’s single point of contact for all administrative, documentation and coordination functions.

K. Deferred Testing: Testing performed at a later time, due to partial occupancy, equipment, load, seasonal requirements, design or other site conditions that disallow the test from being performed prior to substantial completion.

L. Deficiency: A condition in the installation, function or performance of a component, equipment or system that is not in compliance with the contract documents and design. A deficiency will be considered a Cx issue and documented on the Cx Log.

M. Design Professional (DP): Architects, engineers and other consultants involved in the design of the project.

N. Functional Performance Test (FPT): A test of the dynamic function, operation and control of the equipment and systems to verify system performance to the fullest extent. Systems are tested under various operating modes and control sequences including failure modes. The FPTs are performed using manual (direct observation) or monitoring methods. The FPTs can include sequence of operation tests, performance tests, verification tests, integrated systems tests, and trend analysis.

O. HVAC&R: Heating, ventilation, air conditioning and refrigeration.

P. Installation Verification (IV): Field verification and documentation of proper installation of system equipment, assemblies and components, per design documents and manufacturer requirements. The IV process is typically complete when systems are ready for startup or operation. IV is organized and documented under the System Readiness Checklist (SRC) forms.
Q. Monitoring: The recording of parameters (temperature, flow, current, status, pressure, etc.) of equipment operation, which shall be completed using data-loggers or the trending capabilities of BAS or control systems.

R. Owner's Project Requirements (OPR): A document describing the operational and functional requirements of a project, the expectations of how the facility will be used and operated, and the equipment and system expectations and requirements, as defined by the Owner. This document provides an explanation of the ideas, concepts, goals, success criteria, and supporting information for the project.

S. Percent Sampling: Witnessing the startup, checkout or testing of a selected fraction of the total number of identical or near-identical pieces of equipment or systems.

T. Pre-Functional Checks and Tests (PFCT): These are various checks and tests performed on a piece of equipment or system before, during, or after the initial startup and operation, but prior to the FPT phase. They are performed to confirm the system equipment and individual components were installed correctly and are working properly and meeting applicable performance requirements and specifications. For mechanical HVAC systems, examples during the system installation prior to equipment startup include: pipe system hydrostatic pressure tests, checking completion of the pipe system clean and flush, and duct leakage tests. Examples during equipment startup and operation include: checking fan rotation and measuring and checking operating temperatures, pressures and motor electrical parameters. Examples after equipment startup include: the BAS / control system point to point checks, sensor calibrations or accuracy checks, actuator testing; and system TAB. They are all organized and documented under the SRC forms and are to be completed prior to FPTs.

U. Startup: Initial starting or activating of equipment usually performed by the Trade Subcontractor or the Manufacturer’s authorized representative.

V. Systems Manual: A manual that provides the operating staff the information needed to understand and optimally operate the commissioned systems. It expands upon the scope of traditional operating and maintenance documents and is compiled of multiple documents such as the final BOD, single line diagrams, and as-built controls drawings and sequences of operation.

W. System Readiness Checklist (SRC): A construction checklist, typically one or two pages, listing the necessary commissioning tasks and required documentation to verify a system is ready for FPTs, or system operation if no FPTs are performed. The tasks covered in the SRC include IV, Startup and PFCT, and the Trade Subcontractor completed forms for these tasks are attached to the specific SRC. The SRC must be completed and signed by the GC prior to conducting the FPTs.

X. TAB: Testing, Adjusting, and Balancing (TAB) work on the HVAC&R air and water systems to ensure design flow, pressure and temperature conditions are met. Performed by the TAB Trade Subcontractor.

Y. Trade Subcontractor: Typically a subcontractor to the GC who provides and installs specific building components and systems and/or provides certain services.

Z. Trending: Monitoring using the BAS or a control system, to aid in functional testing and to verify system operation and performance under actual operating conditions.

AA. Warranty Phase: The phase of the project immediately after the initiation of the building equipment warranty which spans the entire length of the project warranty.
1.5. DESCRIPTION OF WORK

A. Systems and equipment to be commissioned:
   1. HVAC equipment, controls and the BAS

B. Process equipment are not included in the commissioning scope of work.

C. The work includes the completion and documentation of formal commissioning procedures by
   the GC and Trade Subcontractors.
   1. The GC and Trade Subcontractors shall provide the quality control for the installation,
      startup, checkout and testing of the systems. The commissioning process provides
      independent review throughout the process and qualitative functional performance testing
      in order to formally observe and document the quality control efforts are completed.
   2. Refer to Section 01 91 13, General Commissioning Requirements for summary
      description of the general commissioning process and requirements.
   3. The Trade Subcontractors and the factory authorized service representatives shall be
      responsible for participation in the commissioning process as outlined in this specification
      and Section 01 91 13 General Commissioning Requirements.

1.6. COMMISSIONING PROCESS

A. Submittal Reviews by the CxA
   1. The CxA will review pertinent Trade Subcontractor submittals for the appropriate systems
      in the commissioning scope, concurrently with the Design Professionals and will provide
      review comments to the Design Professionals.
   2. The GC shall provide a submittal log to the CxA for referencing the requested submittals to
      be reviewed by the CxA (for which the GC shall issue to the CxA concurrently with the
      submission to the Design Professionals). Alternatively, the GC shall include the CxA on
      the distribution of all Trade Subcontractor submittals issued to the Design Professionals,
      for systems applicable to this specification.
   3. The GC shall issue the requested submittals to the CxA for review at the same time they
      issue the submittals to the Design Professionals.
   4. The CxA will also use the information from the submittals to develop commissioning forms
      and test procedures.

B. Cx Plan and Form Development
   1. The CxA prepares a Preliminary Cx Plan either during the project final design phase or
      early construction phase. The Cx Plan provides guidance in the execution of the
      commissioning process during construction and will contain the project specific
      commissioning forms.
   2. Commissioning during construction begins with a kickoff meeting conducted by the CxA
      where the CxA reviews the commissioning process and responsibilities with the
      appropriate team members. The CxA presents the Preliminary Cx Plan and discusses the
      project specific requirements.
   3. The CxA develops the SRC forms, which list the commissioning tasks and the associated
      IV, Startup, and PFCT documentation required for each system and equipment to be
      commissioned.
   4. The CxA provides the SRC forms to the GC and Trade Subcontractors for review and
      comment.
5. The CxC shall submit to the CxA, for review and approval, the representative blank IV, Startup, and PFCT forms and plans for completing all IV, Startup, and PFCT tasks, prior to conducting any of these tasks.
   a. IV forms are to provide field verification and documentation of proper installation of system equipment, assemblies and components, typically completed prior to formal Startup. Where appropriate and approved by the CxA, these forms may be combined with the Startup or PFCT forms.
      1) The IV forms are a combination of Trade Subcontractor provided forms (which may include any applicable design drawings, floor plans, details, or single line diagrams that will be field verified) and the applicable equipment IV (pre-startup) checklists contained in the Manufacturer's installation manuals.
      2) The Trade Subcontractors are to verify equipment installation per the Manufacturer's guidelines and requirements, and thus are encouraged to use and complete any applicable equipment IV checklists contained in the Manufacturer's installation manuals, in addition to any IV forms used by the Trade Subcontractors to verify system installation per design.
   b. Startup forms consist of Manufacturer and/or Trade Subcontractor provided forms and plans used to document the completion of formal startup procedures and associated checks and verifications during the startup and initial operation. Where applicable, these forms shall include checks of the equipment internal / factory provided controls including sensors and control devices.
   c. PFCT forms and plans are Trade Subcontractor provided forms and plans used to document the completion and results for the various checks and tests performed before, during, or after startup. For HVAC&R systems, example PFCT tasks include applicable pipe system hydrostatic pressure tests, duct leakage tests, duct cleanliness checks or tests, pipe system flush and clean checks and documentation, hydronic water treatment tests, BAS pre-functional checks (aka point-to-point checks, inclusive of sensor accuracy checks or field calibration, actuator checks, etc.) and system TAB.
   d. The CxA reviews the blank IV, Startup and PFCT forms and plans, and will issue any comments, which may include additions or changes to be made to the forms and plans, and/or supplemental forms may be issued by the CxA, where appropriate, to improve the forms and commissioning process.

6. The CxA will develop and provide Trend Setup Verification forms defining the BAS trend points list and interval, to be completed by the BAS Trade Subcontractor prior to FPTs.

7. The CxA will develop FPT procedures and forms, and provide the draft forms to the GC and Trade Subcontractors for review and comment.

8. The CxA will update and finalize the Cx Plan with equipment specific blank SRC, IV, PFCT and FPT forms.

C. System Readiness (Pre-Functional) Activities
   1. Meetings will be conducted throughout construction with commissioning team members, as required, to plan, coordinate, and schedule commissioning activities, review documentation, and resolve Cx issues.
   2. The Trade Subcontractors shall perform the IV, Startup and PFCT tasks for all systems and equipment (no sampling allowed), unless the contract or design documents allow for sampling of the pre-functional tests (as example, if sampling were allowed for pre-functional HVAC system duct leakage tests).
a. In general, the GC and Trade Subcontractors should complete IV prior to Startup, but where appropriate and approved by the CxA, they can combine IV and Startup into one activity (and Startup is not performed if there are deficiencies identified from the IV).

3. The Trade Subcontractors and the CxC shall document completion of the IV, Startup and PFCT tasks on the IV, Startup, PFCT and SRC forms, and shall complete the SRC forms and attach the completed IV, Startup, and PFCT forms to the SRCs forms.

a. The intent of the SRC forms is for the GC and Trade Subcontractors to certify that the HVAC systems, controls and instrumentation, equipment, and assemblies have been installed, started, calibrated and are operating per the contract and design documents.

4. The CxA will review the completed IV, Startup, PFCT and SRC forms. The CxA will also perform various field observations and reviews, and witness a sample of the Startup and PFCT activities (some PFCT witnessing may be performed as back-checks after PFCT task are completed, e.g., BAS pre-functional checks and TAB).

a. The Trade Subcontractor shall resolve any IV and PFCT results deemed unacceptable by the CxA. And the Trade Subcontractor shall execute a new sample of the PFCT to be witnessed by the CxA. The CxA shall deem the PFCT acceptable after resolution of all issues and any witnessed sampling results in no issues.

5. The CxC shall submit all completed SRC forms to the CxA for review prior to conducting the FPTs. The CxA shall deem the SRCs acceptable after all SRC forms and supporting IV, Startup and PFCT forms are complete and any issues have been addressed.

D. Functional Performance Testing

1. FPTs are to test the dynamic function, performance and control of the equipment and systems under various modes of operation. These tests verify the correct implementation of the sequences of operation and the system performance meets the design criteria. The FPTs are performed using manual (direct observation) or monitoring methods. FPTs include the following types of tests, where applicable:

a. Sequence of Operation Tests

1) Sequence of operation tests are witnessed by the CxA for each unique sequence of operation but may not necessarily be repeated across identical systems, equipment or spaces, if the contractor has verified the same programmed sequence of operation code (as tested) has been programmed across multiple identical systems, equipment or spaces, based sample verification tests witnessed by the CxA (see below).

b. Verification Tests.

1) Verification tests are often less detailed tests than the sequence of operation tests and are typically witnessed by the CxA at a higher sample rate. Examples of verification tests include:

a) verifying the programmed sequence of operation code is the same as the as-tested code per the sequence of operation tests,

b) verifying the alarm points are configured per the sequence of operation tests (without having to repeat the actual sequence tests),

c) reviewing and confirming control point displays on system graphics and required setpoints (for example verifying the BAS VAV min, max cool, max heat airflow setpoints are correct per design),
d) testing certain critical or important sequences with a higher sample rate across identical systems, equipment or spaces, beyond the individual sequence of operation tests.

c. Performance Tests.

1) Performance tests are to be performed after the sequence of operation and verifications tests, and are focused on testing and verifying performance (i.e., HVAC system air and water flow rates, temperatures, pressures are achieved at both minimum and near maximum load conditions). Performance tests are typically witnessed by the CxA at a lower sample rate. Examples include:

a) testing VAV terminal unit maximum airflow rates and reheat coil airside temperature rise are achieved per design (at design air handler static pressure and hot water temperature and differential pressure),

b) testing AHU minimum outside air ventilation rates per design are achieved at both minimum and maximum supply airflows,

c) testing the AHU supply airflow and temperature performance at simulated high cooling load conditions per design.

d) Testing the chilled water system flow and cooling capacity performance at simulated high cooling load conditions per design.

d. Integrated Systems Tests.

1) Integrated systems tests verify the operation and performance of multiple systems together operating in a coordinated, stable and efficient manner. Often the integrated systems tests are combined with the performance tests. Examples include verifying the operation and performance of the central heating and chilled water systems with the performance of terminal and/or air handling units, from simulated minimum to near maximum load conditions, including staging up and down of central equipment (chiller, boilers, pumps, etc.).

e. Trend Analysis

2. The CxA will develop FPT forms that contain:

a. Specific step-by-step procedures to execute the test in a clear, sequential and repeatable format, including any control system point value or setpoint overrides required to simulate a test condition or sequence mode.

b. The expected system response and acceptance criteria of proper performance with a Yes/No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.

c. A section for recording actual system response, notes and comments.

3. Once the SRC forms are complete, the Trade Subcontractors shall execute the FPTs, with the FPTs witnessed by the CxA.

a. The GC and Trade Subcontractors are responsible for ensuring all systems are installed, operating and performing per the requirements of the contract and design documents, and are ready for the FPTs.

b. The Trade Subcontractors shall determine what level of pre-testing is appropriate in order to prepare for the CxA witnessed FPTs.

c. The CxA recommends the Trade Sub-Contractors complete the Title 24 acceptance testing and forms (see paragraph f below) as part of the contractor’s pre-testing and readiness for the CxA witnessed FPTs.
d. A percent sampling approach shall be used for executing the FPTs of identical systems and equipment. The approximate system sampling rates for the manual (direct observation) FPTs are defined in Part 3 of this specification and/or in the Cx Plan.

e. The acceptance criteria for the FPT sampling shall be zero, meaning, any FPTs that do not pass shall require the Trade Subcontractor to resolve the issue for all applicable systems and equipment (even those specifically not in the original sample) and new sample rates selected for a re-test executed by the Trade Subcontractor and witnessed by the CxA. The CxA shall deem the FPTs acceptable after all FPTs, including re-tests, have passed and resolution of all issues completed.

f. The CxA will document the results of all FPTs on the associated FPT forms created by the CxA, unless indicated otherwise on the FPTs, and excluding completion of the Title 24 Certificate of Acceptance forms.

1) Completion of the Title 24 Certificate of Acceptance forms (contained in Appendix A of the Title 24, Part 6 Compliance Manual) is a contractor responsibility, not the CxA responsibility.

2) The responsible Division 22, 23, 25 and 26 Trade Subcontractors are also responsible for providing qualified and certified "Field Technicians" (per Title 24, Part 6 requirements, where applicable when the minimum threshold of state certified technicians has been met) to perform and document the results of the acceptance tests on the applicable Title 24, Part 6 Certificate of Acceptance forms.

4. The Cx Plan will define any required seasonal or deferred testing.

E. Cx Issues and Recommendations

1. Throughout the process, the CxA records Cx issues and recommendations on the Cx Log and distributes the Cx List to the team. The GC and Trade Subcontractors shall correct Cx issues and recheck or retest the system(s) without delay at no additional cost to the Owner. The CxA will verify the completion of the issues and recommendations, and make all amendments to the Cx Log.

F. Training Verification and Final Documentation

1. The GC shall submit a comprehensive Training Plan (with specific training agendas provided by the Trade Subcontractors) for review by the Design Professionals, CxA and Owner, prior to conducting any training. The Training Plan shall meet the specific requirements in the contract documents and specifications for each applicable system to be commissioned and the LEED Enhanced Commissioning requirements, and may include both operations and maintenance (O&M) staff training and building occupant training. The GC shall coordinate with the Owner and/or Owner's Representatives, as needed, regarding any specific requirements for occupant training.

2. The CxA will verify completion of the training by witnessing some training sessions and receiving a copy of all training class sign-in sheets and any training materials / handouts, to be provided by the CxC or Trade Subcontractors.

3. The CxA will develop the Systems Manual (per the LEED requirements), including the current facility requirements, preventative maintenance information and an ongoing Cx plan, with assistance from the GC and Trade Subcontractors.

4. The CxA will complete the Commissioning Report and all associated documentation for the Owner with assistance from the GC and Trade Subcontractors.

G. Post-Occupancy Warranty Phase Commissioning
1. The CxA will report any identified operational or performance issues (identified by the building O&M staff or warranty phase Cx activities) to the CxC via a Warranty Phase Cx Log for resolution by the GC and Trade Subcontractors during or prior to the end of the warranty period.

2. The Trade Subcontractors shall execute any defined seasonal or deferred FPTs, witnessed by the CxA.

3. The CxA may review and analyze trend data during the Warranty Phase and will report any identified issues and recommendations for system improvements from the trend analysis.

4. No later than either 10 months after substation completion or two months prior to the expiration of the first 12-month warranty period of building occupancy, the CxA will return to the facility to interview facility O&M staff, walk the facility and review systems operation and trend data where applicable. Key representatives from the GC and Trade Subcontractors shall attend a site walk-through and meeting, as determined by the CxA.

1.7. COMMISSIONING TEAM

A. The Commissioning Team is responsible for performing the process and achieving successful commissioning results. The Commissioning Team is comprised of the following:

1. Owner and Owner’s Representatives
2. Commissioning Authority (CxA).
3. Design Professionals
4. General Contractor (GC)
5. GC’s Commissioning Coordinator (CxC)
6. Trade Subcontractors responsible for systems covered in this section include:
   a. Mechanical Contractor
   b. BAS / HVAC Controls Contractor
   c. TAB Contractor
7. Manufacturer Representatives supplying equipment, materials, components and controls for the systems to be commissioned.

1.8. RESPONSIBILITIES

A. General.

1. The Commissioning Team and all others involved in the commissioning process shall follow the Commissioning Plan, attend the commissioning kickoff meeting, and attend additional commissioning meetings as necessary.

B. Commissioning Authority (CxA)

1. See Section 01 91 13, General Commissioning Requirements.

C. General Contractor:

1. See Section 01 91 13, General Commissioning Requirements.

D. Trade Subcontractors – General Requirements:
1. Provide and submit for CxA review, the representative blank forms and plans for completing all IV, Startup, and PFCT tasks, including manufacturer's installation checks and startup procedures. Electronic files are acceptable.

2. Provide any equipment and construction submittals and shop drawings, including detailed sequences of operation, and any other requested contract documentation for systems to be commissioned, as requested by the CxA. Electronic files are acceptable.

3. Attend commissioning meetings as directed by the CxA and GC's CxC to facilitate the commissioning process.

4. Assign personnel with expertise and authority to act on behalf of the Trade Subcontractor and schedule them to participate in and perform assigned commissioning tasks.

5. Ensure that any required manufacturer factory tests are performed and provide the factory test data and results where required.

   a. Perform IV, Startup and PFCT tasks for all systems and equipment (no sampling), unless the contract or design documents allow for sampling of these tasks.
   b. Complete all IV, Startup and PFCT documentation clearly and legibly.
   c. Submit all completed IV, Startup and PFCT forms to the CxC and CxA, as part of completing the SRC forms, for review by the CxA.

7. Provide a schedule and access for the CxA to witness any equipment Startup and PFCT tasks. Notify the CxC and CxA at least 10 days in advance of Startup and PFCT tasks.

8. Ensure that any required manufacturer's representative field tests and on-site IV, startup and checkout of selected equipment are performed per the contract documents. Provide completed manufacturer documentation and commissioning forms for these activities to the CxC.

9. Address applicable Cx issues promptly. All IV, Startup and PFCT issues must be resolved before the FPTs can proceed.

10. Assist the CxA in preparing the FPT procedures, clarifying the operation and control of commissioned equipment where the specifications, control drawings or equipment documentation are not sufficient for writing detailed testing procedures.

11. Review the FPT procedures to ensure feasibility, safety and equipment protection, and provide necessary written alarm limits, setpoint changes and overrides to be used during the tests.

12. Setup any additional control system software points, global commands, overrides of any sensor values or relays, and overrides of any setpoints or schedules, to simulate certain conditions and operating modes, in order to conduct the FPTs.

13. Perform the FPTs, with the FPTs witnessed by the CxA. Provide at least 10 days advance notice to the CxC and CxA for scheduling the FPTs.

14. The Division 23 and 25 Trade Subcontractors (Mechanical, TAB and BAS) are responsible for providing qualified and certified "Field Technicians" (per Title 24, Part 6 requirements, where applicable) to perform and document the results of the acceptance procedures (Acceptance Tests) on Certificate of Acceptance forms per Title 24, Part 6.
   a. The GC or the responsible Trade Subcontractor shall be the designated "Responsible Person" per Title 24, Part 6, for certification of the acceptance testing/verification on the Certificate of Acceptance forms (contained in Appendix A of the Title 24, Part 6 Compliance Manual).
15. Setup the BAS and any other control system trends and provide all requested Trend data for the FPTs and post-occupancy warranty phase commissioning review to the CxA.
   a. As an Owner approved alternative, the Trade Subcontractors may provide the CxA remote access to the BAS and any other control system, with the Owner’s permission, which will allow the CxA to easily and directly download the trend data files.

16. Prepare a training agenda for each training class for the equipment and systems to be commissioned.

17. Coordinate with the GC and Owner to schedule and plan training. Execute training of Owner’s personnel per approved training agenda and schedule. Provide copies of training class sign-in sheets and materials / handouts.

18. Prepare O&M Manuals according to the Contract Documents.

19. Assist the CxA in developing the Systems Manual, including providing as-built drawings, controls sequences, setpoints, single-line diagrams, etc., necessary for the Systems Manual.

E. Trade Subcontractors – Specific Mechanical System Requirements

1. In addition to the general Trade Subcontractor responsibilities outlined above, the Mechanical Trade Subcontractor responsibilities during commissioning shall include, but are not limited to:
   a. Provide approved submittals, including shop drawings, control drawings, points list and detailed sequences of operation for each piece of equipment and system to be controlled (including any local, stand-alone controls independent of the BAS controls). The system sequence of operation shall fully describe their equipment components and functionality, including setpoints, failure modes and alarm functions. The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings. Electronic files are acceptable.
   b. Provide a list of any test metering and sensors to be used for sensor and device calibration purposes. All test meter and sensors shall have been calibrated within a year and have calibration documentation.
   c. Submit the Duct Leakage Test Plan(s), for review by the CxA, at least 4 weeks in advance of conducting any required duct leakage pre-functional tests. The Plan shall include the following items:
      1) Floor plan drawings showing the duct section(s) to be tested.
      2) The total duct square footage for each duct section to be tested. Provide supporting calculations showing how the square footage was calculated for each duct section.
      3) The SMACNA duct leakage class for each duct section to be tested, per the project specifications or the SMACNA Duct Leakage Test Manual if not defined in the specifications.
      4) The intended test static pressure for each duct section.
      5) The calculated allowable leakage rate (cfm) for each duct section to be tested, based on the allowable leakage rate (per 100 square feet) from the SMACNA Duct Leakage Test Manual Figure 4-1 at the intended test pressure.
      6) Test fan orifice certificate of calibration sheet and chart showing the orifice pressure drop and airflow (cfm).
d. Submit any applicable Underfloor Air Distribution (UFAD) Leakage Test Plan(s), for review by the CxA, at least 4 weeks in advance of conducting any required UFAD leakage pre-functional tests. The Plan shall include the following items:

1) Floor plan drawings showing the UFAD plenum(s) to be tested.

2) For each UFAD plenum to be tested, provide the following:
   a) The plenum dimensions and calculated area (square footage).
   b) The acceptable maximum leakage criteria (cfm per square foot) for any required Category 1, Category 2 and Total Category 1 + 2 leakage, per the project specifications, and the associated absolute leakage rates (cfm) for each plenum. If the project specifications do not define the leakage criteria, the CxA shall define the leakage criteria with the Owner's approval.

3) The specific tests procedures for each type of test (Category 1 or Total Category 1 + 2), including any associated temporary test taping or sealing to be performed prior to the tests, the plenum test static pressure, the plenum pressure measurement locations and manometers to be used, and any diagnostic procedures (such as smoke testing) to be performed upon tests not passing.

4) Test fan orifice certificate of calibration sheet and chart showing the orifice pressure drop and airflow (cfm).

e. Submit a Hydronic Pipe System Pressure / Leak Test Plan for all applicable hydronic systems, for review by the CxA, at least 4 weeks in advance of conducting any required tests. The Test Plan shall include the section of pipe to be tested, and the test methods, pressures and durations.

f. Submit a Refrigeration Pipe Test Plans for all applicable refrigeration systems, for review by the CxA, at least 4 weeks in advance of conducting any required tests. The Plan shall include the refrigeration piping to be tested, methods and procedures, equipment and gases to be used, pressures and durations.

g. Submit a Clean, Flush and Treatment Plan for all applicable hydronic systems, for review by the CxA, at least 4 weeks in advance of filling any hydronic systems. The Plan shall include the following:

1) The intended minimum durations for all pipe cleaning and flushing, and the associated cleaning agents and corrosion inhibitors to be used.

2) An outline of the water chemical treatment, analysis and testing to be performed after cleaning and flushing is complete. At a minimum, the following shall be included:
   a) the proposed chemicals, corrosion inhibitors and biocides, to be added as part of the water treatment,
   b) outlining the water chemistry analysis and corrosion testing to be conducted,
   c) and the intended final water chemistry limits or ranges (including steel, iron and copper levels) to be achieved, in order to meet the specifications and any specific manufacturer requirements.

3) The timing for submitting the Water Treatment Analysis Reports for review by the Design Professional and CxA.

h. Submit Plans for all other applicable mechanical systems pre-functional testing, per the project specifications, for review at least 4 weeks in advance of any required tests.
i. Participate in any applicable integrated whole building tests under emergency power. This test is initiated by disconnecting the utility power to the building, and it will involve multiple disciplines. All Trade Subcontractors shall participate in the FPTs as required for operation of the inter-related systems.

F. Trade Subcontractors – Specific BAS and HVAC Controls Requirements

1. For the BAS and HVAC&R system controls (inclusive any local equipment factory provided controls or local stand-alone controls not part of the BAS), in addition to the general Trade Subcontractor responsibilities outlined above, the Mechanical and/or BAS Trade Subcontractor responsibilities during commissioning shall include, but are not limited to:

   a. Provide approved submittals, including shop drawings, control drawings, points list and detailed sequences of operation for each piece of equipment and system to be controlled. The system sequence of operation shall fully describe their equipment components and functionality, including setpoints, failure modes and alarm functions. The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings. Electronic files are acceptable.

   b. Provide a complete control points list in MS Excel or other pre-approved format (for all BAS, local equipment provided, and local stand-alone control points). Points list shall include point name, point description, display units (i.e. degrees F, percent, psi), panel identification, point type (AI, AO, BI, BO, virtual/software), field device controlled (through network, dry contact, actuator limit switch or other specific equipment), BAS application or energy management function associated with point, and associated alarm points and parameters, etc. The BAS Trade Subcontractor shall make all points available for continuous trending.

   c. Provide control system diagrams showing all control points, sensor locations, actuators, and controllers.

   d. Provide a list of any test metering and sensors to be used for sensor and device verification and calibration purposes. The list shall include test meter and sensor accuracy for comparison to the BAS and local control system sensor accuracy requirements specified in contract documents. All test meter and sensors shall have been calibrated within a year and have calibration documentation.

   e. Submit representative blank forms for conducting all BAS and HVAC System Controls IV and PFCT tasks to be conducted by the Trade Subcontractors, for review by the CxA, at least 4 weeks in advance of performing any controls related Controls IV and PFCT tasks. For local HVAC equipment factory provided or local stand-alone HVAC controls, these forms can be included in the equipment specific IV and Startup forms (for example, as part of the mechanical contractor’s or the manufacturer representative’s IV and Startup forms for the specific equipment inclusive of all local controls). The forms shall include:

      1) Installation verification checks of the control input and output points (sensors, actuators, relays, etc.) to verify all points have been installed per the points list and the physical installation of each point has been verified.

      2) Control system program setup checks, e.g., point type, range/scale, etc.

      3) Point-to-point checks with the BAS operating system software graphics or local controller display interface or graphics.

      4) Sensor accuracy checks or calibration results:
a) For analog input sensors that are factory calibrated (no field calibration is required per the Specifications):
   i. The control system program setup (as noted above) shall be verified and recorded in the PFCT forms for all sensors, and all sensor readings on the BAS graphics or local controller display shall be recorded on the PFCT forms and shall be checked by verifying the BAS reading is within the expected range.
   ii. Sensor readings that are questionable or outside the expected range shall be checked by the BAS or Mechanical Trade Subcontractor using a hand-held sensor of equal accuracy.

b) For sensors that require field calibration, follow the manufacturer requirements for calibration and record the calibration results in the PFCT forms, including any readings using a hand-held sensor of equal accuracy.

5) Actuator checks:
   a) At a minimum, all actuators shall be physically checked at commanded full open position (100% open), commanded half-open position (50% open) and commanded fully closed position (0% open), and documented on the PFCT forms.

6) Verification of all local equipment control points integrated to the BAS via network interface communications (e.g., BACnet, Modbus, etc.), including both read only and writable points.

f. Submit the completed BAS and HVAC System Controls IV and PFCT forms for review by the CxA.

g. The BAS and/or the Mechanical Trade Subcontractor shall support commissioning by participating in the BAS and HVAC System Controls IV and PFCT Field Review & Back-check, in which the BAS and/or the Mechanical Trade Subcontractor reviews and demonstrates specified results to the CxA, after completing and submitting the BAS and HVAC System Controls IV and PFCT forms.

1) The BAS and HVAC System Controls IV and PFCT Field Review & Back-check shall include field review of the control system sensor/device installations and live readings, and also field demonstrations (back-check) of the pre-functional checks and tests performed by the Trade Subcontractors and witnessed by the CxA, for an approximate 10% to 30% sample, to be selected by the CxA for each major system, or what can be accomplished in 1 full day.

2) Any Cx issues reported by the CxA shall be reviewed and addressed by the BAS and Mechanical Trade Subcontractors, and if required, the PFCT forms shall be revised and resubmitted, prior to performing any FPTs.

h. The BAS Controls and Mechanical Trade Subcontractor shall configure all BAS or local control graphics and programming logic for the sequence of operations and associated setpoints, schedules, and alarms and verify the system operation, including the control loop tuning, prior to starting FPTs.

i. Prior to conducting the CxA witnessed FPTs, place the systems and controls into the operating modes intended for testing. Check all control system safety cutouts, alarms, and interlocks with smoke control and fire-life safety during each mode of operation prior to functional testing. Ensure all systems are operating and performing per the requirements of the contract and design documents, and have been pre-tested per the FPTs, and are ready for the CxA witnessed FPTs.
1) The Trade Subcontractors shall determine the appropriate level of pre-testing, to prepare for the CxA witnessed FPTs.

j. The BAS Trade Subcontractors shall provide any necessary control system global or system level commands and setpoint adjustments necessary to conduct the testing as called out in the FPT procedures.

k. The BAS Trade Subcontractor shall set up the appropriate trends per the Trend Setup Verification forms provided by the CxA and shall provide trend data into a usable electronic format files, such as a text, CSV or Excel format, to the CxA. The CxA will analyze and review the trend data as part of the FPT. These trends shall be setup prior to conducting any sequence of operation functional tests.

1) The trend points list may include both hardware (inputs, outputs) and virtual / software points.

2) The appropriate trend intervals and minimum duration will be provided by the CxA either in a Trend Setup Verification form or in the FPT forms.

3) As an Owner approved alternative, the BAS Trade Subcontractor may provide the CxA remote access to the control system, with Owner permission, that will allow the CxA to easily and directly download the trend data files.

l. The BAS Trade Subcontractor shall also provide trend data to the CxA during the post-occupancy warranty phase for review by the CxA, where required.

m. Participate in any applicable integrated whole building tests under emergency power. This test is initiated by disconnecting the utility power to the building, and it will involve multiple disciplines. All Trade Subcontractors shall participate in the FPTs as required for operation of the inter-related systems.

G. Trade Subcontractors – Specific TAB Requirements

1. In addition to the Trade Subcontractor responsibilities outlined above, the TAB Trade Subcontractor responsibilities during commissioning shall include, but are not limited to:

a. Submit a TAB Plan and Qualifications to the Design Professional and CxA for review, at least 4 weeks in advance of conducting any required TAB work, in addition to any other submittal requirements per the specifications. Electronic files are acceptable. The TAB Plan and Qualifications shall include the following:

1) An outline of the TAB procedures and approach for each system type. The TAB procedures and approach shall satisfy the contract documents and TAB specifications. If TAB procedures and approach are not defined in the contract documents or TAB specifications, then the TAB procedures and approach shall meet the requirements of NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems Section 7.3 (Preliminary TAB Procedures) and/or AABC National Standards Section 20.4 (Procedures).

2) A project specific list of the BAS control sequence of operation setpoints that will be determined by TAB, and the associated specific procedures to determine the BAS setpoints. The TAB Trade Subcontractor shall coordinate with the BAS Trade Subcontractor to obtain and review the sequence of operation.

3) The associated TAB forms and the drawings to be used in the TAB work. It’s recommended that the forms be pre-filled with all available project, site, and design parameters.

4) TAB contractor qualification certificates.

5) TAB instrument calibration certificates.
b. Provide access for the CxA to witness TAB work. Notify the CxC and CxA at least 10 days in advance of TAB work.

1) Immediately report any issues and deficiencies discovered which may affect or delay the commissioning process.

c. Submit a Draft / Preliminary TAB Report with the completed field forms and data to the Design Professional and CxA for review, within 72 hours following completion of the TAB, and prior to any TAB Field Review & Back-check conducted with the CxA, and prior to conducting the FPTs. Respond to and address comments provided by the DP and CxA.

d. The TAB Trade Contractor shall support commissioning by participating in the commissioning TAB Field Review & Back-check, in which the TAB Trade Contractor demonstrates specified results to the CxA, after completion of the Draft TAB Report.

1) The TAB Field Review & Back-check shall include field demonstrations of any final setpoints and back-check measurements of the air-side and water-side systems, performed by the TAB Trade Contractor and witnessed by the CxA and/or the Design Professional, for an approximate 10% to 30% sample to be selected by the CxA, or what can be accomplished in 1 full day.

2) If the back-checks yield results that are outside the TAB tolerances for more than 10% of the sample, the TAB shall be considered incomplete.

3) The TAB Field Review & Back-check measurements shall be recorded on the Final TAB Report or a separate form or appendix attached to the Final TAB Report, for documentation purposes.

e. Submit the Final TAB Report to the Design Professional and CxA for review after review of the Draft TAB Report and completion of TAB Field Review.

1.9. SUBMITTAL REQUIREMENTS FOR COMMISSIONING

A. Trade Subcontractor Commissioning Forms. The Trade Subcontractors shall submit to the CxA all applicable representative, blank forms and plans for IV, Startup and PFCT tasks for the project (as listed in 1.8 Trade Subcontractor Responsibilities), at least 4 weeks in advance of performing any of these tasks.

1. The draft SRC forms issued by the CxA will list the required IV, Startup and PFCT forms and plans, required for this project. The Trade Subcontractor shall review the draft SRCS to ensure all applicable, representative IV, Startup and PFCT forms and plans have been submitted for the CxA review.

2. The CxA will review these submitted commissioning forms including whether all project specific requirements are included.

3. The CxA may request additional data, changes and/or additions to these forms to confirm application prior to their use. If the Trade Subcontractor cannot submit sufficient forms, the CxA will provide forms based on the construction documents and specifications, manufacturer installation manuals and procedures, and/or industry standards or guidelines.

B. Training Agenda. The Trade Subcontractors shall develop a Training Agenda for each training session, per the requirements of the contract documents and specifications, and the LEED Enhanced Commissioning requirements, and may include both operations and maintenance (O&M) staff training and occupant training. The Training Agenda shall be included in the comprehensive Training Plan to be submitted by the GC for review by the CxA, Design Professionals, and/or the Owner (see Section 01 91 13). The GC and Trade
Subcontractors shall coordinate to fully develop the comprehensive Training Plan with input from the Owner.

1. The Training Agenda for each training session shall include the following:
   a. equipment and/or systems covered;
   b. recommended attendees;
   c. proposed location;
   d. estimated duration;
   e. level of instruction to be provided and an outline of the training topics and subjects to be covered;
   f. list of any materials and handouts to be provided (or provided in advance);
   g. company to provide the training and the instructor’s name and qualifications.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1. MEETINGS, SCHEDULING AND COORDINATION

   A. See Section 01 91 13.

3.2. DOCUMENTATION

   A. The Trade Subcontractors have specific responsibilities for assisting in the development of equipment check, test and verification procedures and forms, and in performing and documenting commissioning tests, as directed by the CxC and as overseen by the CxA.

   B. The Trade Subcontractors shall provide, wherever the Contract Documents require, system checks and testing, test reports, factory test data and reports, checklists, operational verifications and demonstration, etc., whether specified or not in the commissioning sections.

3.3. TEST EQUIPMENT

   A. The Trade Subcontractor shall provide all test equipment in sufficient quantities to execute all Pre-Functional and Functional Performance Tests in an expedient fashion.

   B. The test equipment shall be of industrial quality and suitable for testing and calibration with accuracy within the tolerance necessary to demonstrate system performance per the Contract Documents. If not otherwise specified, the following minimum requirements apply:
      1. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 degree F and a resolution to + or − 0.1 degree F.
      2. Pressure sensors shall have an accuracy of + or − 2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year.

   C. The test equipment shall have calibration certification per equipment manufacturer’s interval level or within one year if not otherwise specified. The calibration tags shall be affixed or certificates readily available for all test equipment.

3.4. SYSTEM READINESS: INSTALLATION VERIFICATION, STARTUP, PRE-FUNCTIONAL CHECKS & TESTS
A. The Trade Subcontractors shall conduct all startup procedures and tests without compromise to human or equipment safety. The GC and Trade Subcontractors shall be responsible for the liability and safety of conducting all startup, checks and tests.

B. The Trade Subcontractors shall clearly identify and list any issues and deficiencies resulting from the IV, Startup and PFCT tasks on the associated forms and immediately notify the CxA. The CxA will additionally document the issues on the Cx Log. Once issues and deficiencies are corrected and verified, the associated forms shall be updated and resubmitted, and any necessary field review, back-checks or re-tests witnessed by the CxA.

C. The CxC and Trade Subcontractors shall provide a minimum 10 days’ notice to the CxA for witnessing equipment Startup and PFCT tasks.
   1. The sample rates for the CxA witnessing of duct and pipe system PFCT tasks and equipment startups, will be defined in the Cx Plan. For most tasks, the CxA will witness the first test for any applicable duct and/or supply plenum leakage testing and the first startup for each main equipment type.
   2. For the BAS Pre-Functional Checks and for TAB, the CxA will witness a Field Review & Back-check of each, as described in Part 1, Paragraph 1.8.

D. The GC and Trade Subcontractors shall ensure the completion of the SRC forms. Review and approval of the completed SRC forms by the CxA is required prior to conducting the FPTs.

3.5. FUNCTIONAL PERFORMANCE TESTS

A. The Trade Subcontractors shall perform all FPTs per the final FPT forms and complete the Title 24 Part 6 acceptance test requirements and Certificate of Acceptance forms, for all systems and equipment in the scope of commissioning. The FPTs shall be witnessed by the CxA. The Trade Subcontractors may need to complete off hours or weekend work in order to complete the FPTs.

B. The CxA will document all testing results on the FPT forms, not including the Title 24 Certificate of Acceptance forms. The completion of the Title 24 Certificate of Acceptance forms is a contractor responsibility.

C. As outlined in the Part 1 general commissioning process, a sampling approach shall be used for the FPTs of identical systems and equipment, using the sample rates as defined in the Cx Plan, with the specific systems and equipment selected by the CxA.

D. The Trade Subcontractors shall determine what level of pre-testing is appropriate in order to prepare for the CxA witnessed FPTs.

E. The CxC and Trade Subcontractors shall coordinate all FPTs with the CxA, and provide a minimum of 10 days’ notice prior to conducting each test.

F. The GC and Trade Subcontractors shall have responsibility for the liability and safety of conducting all functional performance tests.

G. The Trade Subcontractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. to execute the test according to the test procedures.
   1. The Trade Subcontractors shall provide any necessary control system global or system level commands and setpoint adjustments necessary to conduct the testing as called out
in the FPT procedures. For example, globally adjusting the space temperature setpoints for all terminal units on a floor or AHU or the building. Or as another example, globally overriding the economizer status command for all AHUs.

H. At completion of the test, the Trade Subcontractor shall return all affected building equipment and systems to their pre-test normal condition.

3.6. FUNCTIONAL PERFORMANCE TESTS – TREND ANALYSIS

A. The CxA may conduct trend analysis as part of the FPT process, after completion of the onsite field conducted FPTs and correction of all issues and deficiencies, to verify integrated system operation and performance.

B. The CxA will prepare a BAS trend points list including the trend interval. The BAS Trade Contractor shall set up the trend log definitions prior to the start of the sequence of operation FPTs.

C. The BAS Trade Subcontractor shall provide the trend to the CxA in an electronic format, either a text file, CSV file or Excel file, with related system parameters grouped together. The estimated duration for the trend data is 1 to 3 weeks (with a minimum of 1 weeks’ worth of data).

D. If the CxA discovers any control or performance issues during trend analysis, the Trade Subcontractors shall correct the issues and provide new trend data for analysis verification by the CxA.

3.7. COMMISSIONING ISSUES, BACK-CHECKS AND RE-TESTS

A. When Cx issues are identified during testing, the CxA will discuss with the executing Trade Subcontractor and/or CxC and determine whether or not testing can proceed. The CxA may allow immediate correction of minor issues and deficiencies identified during testing. The Cx issue and any identified resolution will be documented on the test form in use in addition to the Cx Log.

B. The CxA will maintain and update the Cx Log, and document the issue resolution process. Copies will be distributed to the GC, Owner, and Trade Subcontractors as appropriate. The Trade Subcontractors shall provide updates and comments regarding issue status and resolution.

C. The Trade Subcontractors shall promptly correct all Cx issues. The responsible party shall correct the issue and inform the CxC and CxA of the resolution and completion date, and update the Cx Log accordingly (in the fields assigned for contractor updates).

D. The CxA will record completion on the Cx Log after a successful witnessed re-test, field review, back-check, verification obtained through appropriate documentation or photographs, or acceptance by the Design Professional or Owner. The CxC shall reschedule any applicable re-testing with the CxA and Trade Subcontractor. The Trade Subcontractor shall retest until achievement of passing performance or Owner acceptance of the noted issue.

1. Where sampling is used for the PFCTs and FPTs, the results shall be deemed acceptable once all noted issues are resolved and any new sample tests or checks have passed.

E. Additional parties may require input during a dispute regarding a Cx issue. Regardless of the validity or responsibility of the issue, the CxA will have the final interpretive authority on Cx issues and the Owner will have the final approval authority.
F. The CxA may recommend solutions to Cx issues. However, the GC and Trade Subcontractors ultimately have the burden of responsibility to solve, correct and perform required retests.

G. Back-checks, Verifications and Re-testing:
   1. The CxA will witness one (1) re-test or will perform one (1) field back-check or verification of any Cx issue.
   2. The CxA’s total onsite time for re-test witnessing and field verification or back-check of Cx issues will be limited to no more than 2 work days (full 8-hour work days) for all applicable systems in the commissioning scope.
   3. The Owner may back-charge the GC for any additional fees from the CxA, resulting from any additional re-testing or field back-checks or verification beyond this allocated total time.
   4. The CxC must provide a minimum 48 hours’ notice for scheduling any re-testing, though the CxA will attempt to accommodate a shorter timeframe if feasible.
   5. Any required re-testing shall not be considered a justified reason for a claim of delay or for a time extension.

H. For any re-testing required, the CxA will determine if the entire test must be re-tested or if it is acceptable to re-test specific portions of the test that had failed.

3.8. DEFERRED & SEASONAL TESTING

A. Before or during the end of the first year warranty period, the Trade Subcontractor shall complete any seasonal or deferred testing, required per the design specifications and as defined in the Cx Plan. The Trade Subcontractors shall complete tests in the same manner as all other commissioning tests, including CxA witnessing.

B. The CxC and Trade Subcontractor shall coordinate with CxA and Owner and schedule all deferred and seasonal testing.

3.9. TRAINING VERIFICATION

A. The CxC and Trade Subcontractors shall coordinate and schedule the training for the Owner’s facility and operations personnel, and building occupants. The CxC shall ensure that training is completed per the requirements of the contract documents and specifications.

B. Trade Subcontractors responsible for specific equipment and system training shall submit to the CxC, a written training agenda for each training class for the equipment and systems to be commissioned. The GC shall submit a comprehensive Training Plan, including the specific training agendas, to Owner, Design Professionals and CxA for review and approval. See also Section 01 91 13.

C. The CxA will review the Training Plans for commissioning verification prior to conducting the actual training.

D. For verification of actual training conducted, the CxC shall submit to CxA ‘attendee signed’ attendance sheets for each training session conducted and a copy of any final training presentations or handout materials.

3.10. COMMISSIONING ACCEPTANCE, CLOSE-OUT AND REPORTING

A. Completion of the main commissioning activities (system readiness checks, functional performance testing, and training) shall be accomplished as a prerequisite for substantial
completion. Completion of any re-testing shall be completed prior to final acceptance of commissioning.

B. After completion of the main commissioning activities and following review of the completed commissioning documents, test results and the current Cx Log with the Owner, the Owner will indicate whether they accept completion of the project construction phase commissioning or if not, the requirements for acceptance. Upon Owner acceptance, any remaining open Cx issues will be transferred to the warranty phase Cx Log for tracking resolution and completion as part of the warranty phase commissioning.

C. Upon completion of all commissioning activities, the CxA will prepare and submit to the Owner a Cx Report detailing all completed commissioning activities and documentation. The CxC shall support this effort by providing all GC and Trade Subcontractor commissioning documentation.

D. The CxA will complete a Systems Manual for the systems and equipment commissioned, following the LEED requirements, with assistance provided by the CxC and Trade Subcontractors. The Systems Manual will provide the operating staff the information needed to understand and optimally operate the commissioned systems. It will also include the current facility requirements, O&M preventative maintenance information, and an ongoing commissioning plan. Per LEED enhanced commissioning requirements, the Systems Manual will contain the following sections and detail:

1. Current facility requirements including the final version of the BOD and systems narrative.

2. Final equipment list.

3. Systems single line diagrams or schematics.

4. Final as-built sequence of operations, control drawings (P&IDs), points lists and setpoints.

5. Additional operating instructions for key systems or integrated building systems such as water-side and air-side HVAC systems and controls, lighting controls, etc.

6. Recommended schedule of major preventative maintenance requirements and frequency.

7. Ongoing Cx Plan
   a. Definition of the ongoing commissioning process, defined roles and responsibilities, a recommended schedule for recommissioning the systems;
   b. Recommended schedule for retesting of commissioned systems with blank test forms from the Final Commissioning Plan.
   c. Recommended schedule for calibrating sensors and actuators.

3.11. POST-OCCUPANCY WARRANTY PHASE COMMISSIONING

A. The Trade Subcontractors shall execute any defined seasonal or deferred FPTs, witnessed by the CxA.

B. The CxA may review BAS trend data during the Warranty Phase. The BAS Trade Contractor shall be responsible for providing post-occupancy trend data to the CxA.

C. The CxA will report any identified issues and recommendations to the CxC via a Warranty Phase Cx Log for review and resolution by the GC and Trade Subcontractors prior to the end of the warranty period, for any issues or recommendations identified either by the CxA or the Owner. The CxC shall work with the Trade Subcontractors and O&M staff to make corrections and adjustments as required to address the issues and recommendations.
D. Key representatives from the GC and Trade Subcontractors shall attend a near end of warranty commissioning review meeting, to be scheduled with the Owner’s facility staff and the CxA, no later than either 10 months after substation completion or two months prior to the expiration of the first 12-month warranty period of building occupancy.

1. During this meeting, the operation of the systems will be discussed with the Owner’s staff, the results of any commissioning trend analysis will be reviewed and the Warranty Phase Cx Log will be reviewed. If needed, a walk-through of the systems with the Owner’s staff will be conducted.

2. Next steps and actions items for any open Cx issues and recommendations will be discussed and documented via meeting minutes or a field report issued by the CxA. The intent is to resolve any open Cx issues prior to the end of the warranty phase.

E. After correcting noted Warranty Phase Cx issues, the CxC shall notify the CxA, and the CxA will back-check and verify resolution of the issues and recommendations.

F. Issues identified during the warranty period will remain warranty phase Cx issues until satisfactory completion by Trade Subcontractors, even if the warranty period expires during the correction and back-check period.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. All Sections of Division 23

1.2 SUMMARY
A. Installation of sensing and control devices.

1.3 QUALITY ASSURANCE
A. All HVAC equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.
B. Standards: Comply with all applicable codes or standards governing process piping, system materials, application, and installation.
C. Welding Qualifications: Welders shall be certified in accordance with American Welding Society "Standard Qualification Procedure".

PART 2 - PRODUCTS

2.1 EQUIPMENT
A. Hot water modulating control valves, Belimo or Equal
1. Sizes ½ inch to 2 inch shall be characterized Control Ball valves. A Tefzel, flow-characterizing disc shall be installed in the inlet of two-way characterized control valves and in the control port of three-way valves. The valve trim shall utilize a stainless steel ball and stem for all water or glycol solutions up to 60%. For water applications, an optional chrome plated brass ball and stem may be used for sizes ¾ inch and smaller. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Valves shall have a self-aligning, blow-out proof, brass stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon seats shall be used. Bodies ½ inch to 1-1/4 inch shall be rated for 600 pounds per square inch and sizes 1-1/2 inch to 3 inch at 400 pounds per square inch. Valves shall have a four bolt mounting flange to provide a 4 position, field changeable, electronic actuator mounting arrangement.
2. Sizes 2 ½ inch to 6 inch shall be cast iron flanged, rated at 125 pounds per square inch gauge Working pressure. The valve stem shall be stainless steel, valve plugs shall be stainless steel guided to ensure correct seating. Stem packing shall be Teflon, spring loaded EP V-Rings to minimize stem friction. Stem lift shall be ¾ inch to 1½ inch. The control valves shall be equal percentage with composition replaceable discs providing tight shutoff.
3. Electronic actuators used on valves shall be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad. Actuators shall be fully modulating (proportional), floating/tri-state, or two position as required. Actuators shall be capable of operating on 24VAC, 120VAC, 230VAC or 24VDC and class 2 wiring as dictated by the application. Power consumption shall not exceed 10VA or AC, including 120VAC actuators and 8 watts per actuator for DC applications. For power-failure/safety
applications an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return actuators with more than 60 in-lb of torque shall have a metal, manual override crank. There shall be a visual valve position output signal for electronic feedback to the DDCS. The actuator shall provide the minimum torque required for proper valve close off, with an approximate running time of 2 minutes for full stroke. The actuator shall be designed with current limiting motor protection. End of travel switches shall not be acceptable. All valves shall have a minimum resolution of 40:1. All actuators shall be UL listed.

4. The manufacturer shall warrantee all actuator/valve assemblies for a period of 5 years from date of installation.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Valves

1. All valves in chilled and heating hot water lines shall be ball valves, unless otherwise shown.

2. Provide valves and strainers of the same size as the pipe in which they are mounted unless specifically shown otherwise.

3. All valves shall be properly packed and lubricated.

4. Provide valves with trim proper to the service on which they are applied.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating ALC for BACtalk Native BACnet based Temperature Control System based upon the ANSI/ASHRAE™ Standard 135–2016, BACnet.

B. Provide one (1) hard copy of all Operation & Maintenance manuals. The manuals shall also include all final controls diagrams.

C. Provide all necessary hardware and software to meet the specified functional requirements.

D. Prepare individual hardware layouts, interconnection drawings and control loop configuration data from project design data.

E. Implement the detailed design for all system input/output points, distributed control and system data bases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

F. Provide and install all controllers, panels, and all interconnecting data communication network cables and all interconnecting cables between all operator terminals and peripheral devices (such as printers, etc.) called for in this section.

G. Provide as-built documentation, software, and all Direct Digital Control (DDC) control logic and all associated support documentation on approved media which accurately represents the final system.

H. Supply all equipment and accessories in accordance with the requirements of all applicable national, state and local codes.

I. Scheduled equipment performance is minimum capacity required.

J. Scheduled electrical capacity shall be considered as maximum available.

K. Unless noted otherwise, all conduit and wiring associated with the temperature control system, regardless of voltage, is included as part of this Section. Obtain power for temperature control devices from the nearest available adequate source.

L. Control system shall incorporate a California Energy Commission listed and approved fault detection and diagnostic (FDD) economizer controls and Title 24 requirements for HVAC operation with space CO2 sensors if shown on the plans.

M. All new system programming and graphics shall be installed on the CCCD Server.
1.2 REFERENCES


CEC - California Electrical Code

NEMA - National Electrical Manufacturer's Association

NFPA - 70 National Electrical Code (NEC)

UL - Underwriters Laboratories, Inc

1.3 SUBMITTALS

A. Submit one electronic copy of shop drawings of the entire control system. Provide point to point wiring diagrams and engineered drawings, complete list of equipment and materials including manufacturer's catalog cuts, and installation instructions. Provide a recommended spare parts list.

B. Provide complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Indicate terminal identification for all control wiring on the shop drawings.

C. Provide a complete written Sequence of Operations with the submittal package.

D. Provide the following minimum system documentation:

1. System configuration diagrams in simplified block format.

2. Input / Output point and alarm point summary listing.

3. Electrical drawings showing all system internal and external connection points, terminal block layouts and terminal identification.

E. As part of Maintenance and Operating Data, provide manufacturer's instructions and drawings for installation, maintenance and operation of all materials.

F. Overall system operation and maintenance instructions, including preventive maintenance and troubleshooting instructions.

G. Upon completion of the work provide a complete set of 'record' drawings including manufacturer's descriptive literature, operating instructions, and maintenance and repair data all in accordance with the requirements of Section 23 05 00.

H. Provide one CD ROM to the Owner with all Control System As-Built AutoCAD Drawings.
1.4 MANUFACTURER QUALITY ASSURANCE

A. Acceptable Control System Manufacturer is Automated Logic Corporation, no equal.
   
   1. All new Controllers will communicate with existing EMS and be programmed per
      the sequence of operations.
   
   2. All Graphic Screens and Alarms for this project will be setup to be monitored and
      controlled from the (E) EMS Server Computer located at the District Maintenance
      office.

B. All BACnet application specific controllers submitted for use on this project must be
   certified as complaint with BACnet through the BACnet Manufacturers’ Association
   (BMA) BACnet Testing Lab and must have a “BTL Mark”. The temperature control
   system must be developed using existing proven equipment and must be readily
   available from inventory of the controls manufacturer or vendor at the time of bid.

C. Native BACnet System Manufacturer must have at a minimum 500 operating projects
   utilizing the proposed native BACnet System. Provide 10 references of similar pro-
   jects (include project name, contact, phone number, location, consultant, value of
   contract, and a brief description of the control system and how it operates) and submit
   45 days prior to bid for review process.

D. All controllers used on project must be of regular manufacture and be readily available
   from inventory of the BACnet System Manufacturer.

E. Provide standard components, of regular manufacture for this application for all
   materials and equipment. All systems and components shall have been thoroughly
   tested and proven in actual use.

F. Operator workstation (existing). All controllers shall be native BACnet devices. No 3rd
   party gateways shall be used for communication to controllers installed under this
   section.

G. Provide all necessary BACnet-compliant hardware and software to meet the system’s
   functional specifications. Provide Protocol Implementation Conformance Statement
   (PICS) for Windows-based control software and every controller in the system.

H. All BACnet based peer-to-peer controllers, central system controllers and local user
   displays shall be UL listed under Standard UL 916, category PAZX.

I. All electronic equipment shall conform to the requirements of FCC Regulation, Part
   15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

1.5 EMS SYSTEM CONTRACTOR QUALITY ASSURANCE

A. Responsibility: All work described in this section shall be engineered, installed, 
   wired, circuit tested calibrated and programmed by regularly employed control sys-
   tem engineers and electricians and technicians of the authorized temperature control
   system factory representative or branch office of the listed approved manufacturer.
System Engineering, Programming and Installation shall not be subcontracted. The supplier of the BACnet Temperature Control and Energy Management System shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him. Contractor must have a valid C-10 and C-20 license to bid this project.

B. Component Testing and Availability: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. The manufacturer prior to shipment shall individually test each and every controller, sensor, and all other DDC components. EMS System Contractor or Manufacturer must certify that any DDC part can be replaced within 5 working days.

C. Unacceptable Bids: Bids by wholesalers, parts distributors, contractors or franchised dealers or any firm whose principal business is not that of installing automatic temperature control systems shall not be acceptable.

D. Experience: Energy Management System Contractor (EMSC) shall have been in business and licensed by the State of California for a minimum of five continuous years prior to this project bid. EMSC must have been a factory authorized representative for a minimum of five of the contractors proposed manufacturer's products and systems.

E. EMSC must have performed, from an office not more than 20 miles from project site at least 25 projects, each of which included the installation of not less than 250 hardware I/O points, using the contractors proposed manufacturer's products and systems. Five of the 25 projects must have included the installation of not less than 1,500 hardware I/O points using the contractors proposed manufacturer’s products and systems.

F. EMSC shall have on staff a full time Mechanical Engineer that is a licensed Professional Engineer by the State of California, having not less than four years experience with the contractors proposed manufacturer’s products and systems.

G. EMSC shall have on staff a full time Applications Engineer and Control System Programmer, having not less than three-years experience with the contractors proposed manufacturer’s products and systems.

H. EMSC shall have on staff a minimum of three full time control technicians, Senior control technician shall have not less than three years experience, junior technicians shall have not less than one years experience with the contractors proposed manufacturer’s products and systems.

I. EMSC shall have a full time service department with service available 24 hours a day, seven days a week. Service department will have been established for a minimum of five years and be staffed with factory trained and authorized service technicians capable of servicing all aspects of the control systems depicted on these plans.
J. Service department shall have on staff a full time control system telephone support technician available during normal business hours dedicated to taking customer support calls and having the ability to call the project site and perform on-line diagnostics.

K. EMSC shall assign an in-house project manager to provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging, and commissioning.

PART 2 – PRODUCTS

2.1 OPERATOR'S WORKSTATION (Existing at District Office)

A. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 clients simultaneously.

N. Workstation/Server Hardware (Existing)

1. Server Hardware existing at District Office. Provide upgrade per item M below.

M. Software

1. Update the WebCTRL software to the latest version including software, installation, conversion and training.

2. At the conclusion of project, contractor shall leave with owner a CD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.2 WEB INTERFACE (Existing)

A. Web Client

1. EMCS supplier shall provide an HTML5-based browser access to the AWS as part of standard installation. User must be able to access all displays of real-time data that are part of the AWS using a standard web browser. Web browser shall tie into the network through owner-supplied Ethernet network connection. The web client shall support a minimum of 200 users with a single license.

2. Browser shall be standard version of Microsoft Internet Explorer v10.0 or later, Firefox v19.0 or later, Chrome v24.0 or later, and Safari v7.1.1 or later. No special vendor-supplied software shall be needed on computers running browser. Data shall be displayed in real-time and update automatically without user interaction.
3. Web pages shall be automatically generated using HTML5 from the data display files that reside on the AWS. Any system that requires use of an HTML editor for generation of web pages shall not be considered.

4. Access through web client or thick client shall utilize the same hierarchical security scheme as the AWS. User shall be asked to log on once the client makes connection to the AWS. Once the user logs on, any and all changes that are made shall be tracked by the AWS. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged on to the system, regardless of whether those changes were made using a web client, thick client or through the AWS.

5. Shall provide User Session Management including the ability to view all connected user sessions to the web client, see how long they have been active/inactive for each unique session, and force log-out for any or all sessions.

6. Shall provide menu-style navigation access to primary features, i.e. alarm history, DataView, Search scheduled points and Zones, System Activity, User Session Management, and Top Display

7. Web client shall, at a minimum, support the following tablets:
   a. Android platform:
      1. Google Nexus
      2. Samsung Galaxy Note
   b. Apple platform
      1. Ipad
      2. Apple Ipad Mini

2.3 BUILDING CONTROLLER

A. General Requirements

1. BACnet Conformance
   a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.
   b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
2. Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.

3. The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.

4. The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.

5. The controller shall be capable of running up to six (6) independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.

6. The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a wide area network (WAN) or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.

7. Programming shall be object-oriented using control function blocks and support DDC functions. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.

8. The programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator’s workstation or field computer.

9. Controller shall have 6,000 Analog Values and 6,000 Binary Values.

10. Controller IP configuration can be done via a direct USB connect with an operator’s workstation or field computer.

11. Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.

12. Global control algorithms and automated control functions shall execute using a 64-bit processor.

13. Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.

14. Controller shall support two (2) on-board EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
a. Ports are capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.

15. Controller shall support two (2) ports—each of gigabit speed—Ethernet (10/100/1000) ports.

a. Ports are capable of supporting various Ethernet protocols including, but not limited to BACnet IP, FOX, and Modbus.

16. All ports shall be capable of having protocol(s) assigned to utilize the port's physical connection.

17. The controller shall have at a minimum four (4) onboard inputs, two (2) universal inputs and two (2) binary inputs.

18. Schedules

a. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.

b. Each building controller shall support a minimum of 380 BACnet Schedule Objects and 380 BACnet Calendar Objects.

19. Logging Capabilities

a. Each building controller shall log as minimum 2,000 objects at 15-minute intervals. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

b. Logs may be viewed both on-site or off-site using WAN or remote communication.

c. Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.

d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

20. Alarm Generation

a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

b. Each alarm may be dialed out as noted elsewhere.

c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.

d. Controller must be able to handle up to 2,000 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.
21. Demand Limiting
   a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 1,200 loads using a minimum of two types of shed programs.
   b. Load shedding programs in building controller modules shall operate as defined in section 2.1.J of this specification.

22. Tenant Activity Logging
   a. Tenant Activity logging shall be supported by a building controller module. Each independent module shall support a minimum of 380 zones.
   b. Tenant Activity logging shall function as defined in section 2.1.K of this specification.

B. BACnet MS/TP
   1. BACnet MS/TP LAN must be software-configurable from 9.6 to 115.4Kbps
      a. Each BACnet MS/TP LAN shall support 64 BACnet devices at a minimum.
      b. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. BACnet IP
   1. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP inter-network, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the local area network (LAN).
   2. Must support interoperability on WANs and campus area networks (CANS), and function as a BACnet Broadcast Management Device (BBMD).
   3. Each controller shall support at a minimum 128 BBMD entries.
   4. BBMD management architecture shall support 3,000 subnets at a minimum.
   5. Shall support BACnet Network Address Translation.
   6. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
D. Expansion Ports

1. Controller shall support two (2) expansion ports.
   a. Combining the two on-board EIA-458 ports with fully loaded expansion ports, the controller shall support six (6) EIA-485 trunks simultaneously.

2. Expansion cards that mate to the expansion ports shall include:
   a. Dual port EIA-485 card.
   b. LON network card.

E. Power Supply

1. Input for power shall accept between 17 and 30VAC, 47 and 63Hz.

2. Optional rechargeable battery for shutdown of controller including storage of all data in flash memory.

3. On-board capacitor will ensure continuous operation of real-time clocks for minimum of 14 days.

G. Controller shall be in compliance with the following:

1. UL 916 for open energy management

2. FCC Class B

3. ROHS

4. IEC 60703

5. C-Tick Listed

H. Controller shall operate in the following environmental conditions:

1. -4 to 149 °F (-20 to 65 °C) without optional battery, or 32 to 122 °F (0 to 50 °C) with optional battery.

2. 0 to 95% relative humidity (RH), non-condensing.

2.4 CONTROLLERS

A. Provide one or more native BACnet application controllers for each air handler and or Fan coil unit. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.
B. BACnet Conformance

1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as native BACnet devices. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary such as Files Functional Group, Reinitialize Functional Group and Device Communications Functional Group.

2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that accept 3K and 10K thermistors, 0–10VDC, 0–5 VDC, 4–20 mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of 3 inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0–10VDC or 0–20mA. Software shall include scaling features for analog outputs. Application controller shall include 24VDC voltage supply for use as power supply to external sensors.

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator’s terminal. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator’s terminal section.

E. Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.
2.5 APPLICATION SPECIFIC CONTROLLERS (HP'S, AC'S, FC'S)

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. BACnet Conformance

1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as native BACnet devices. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary such as Files Functional Group, Reinitialize Functional Group and Device Communications Functional Group.

2. Please refer to section 22.2, BACnet Functional Groups in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, 4–20 mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

E. Application controller shall include support for intelligent room sensor. Display on room sensor shall be programmable at controller and include an operating mode
and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.6 SENSORS AND MISCELLANEOUS DEVICES

A. Temperature Sensors

1. All temperature sensors to be RTD type, 10k Ohm, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches above finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.

B. Intelligent Room Sensor with LCD Readout

1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.

2. The Intelligent Room Sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in Fahrenheit or Centigrade.

3. Override time may be set and viewed in half-hour increments. Override time count down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.

4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list.

5. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

6. MS4-THC shall incorporate CO2 gas sensing in conjunction with space temperature and humidity sensing.
2.7 BTU METER AND FLOW METER

A. BTU & Flow Meter

1. Provide an Onicon System 10-BAC or equal BTU meter. Meter shall be BAC-net MS/TP compatible. Provide auxiliary input. Provide 24 VAC.

2. Provide an Onicon F-3500 Series or equal inline electromagnetic flow meter. Provide low voltage control power, carbon steel body with PTFE liner material. Provide integral mount electronics enclosure and (2) 316 Stainless Steel electrodes.

PART 3 – EXECUTION

3.1 GENERAL

A. All electric wiring and all installation work including piping of control systems and internal wiring of panelboards for temperature control and indicating systems shall be done by an authorized representative of the controls manufacturer whose primary business is the installation and maintenance of temperature control and indicating systems. Wiring shall conform to National Electric Code.

B. Identify each item of control equipment with stamped tape firmly attached to equipment and each panel with nameplate of 1/16 inch laminated plastic with black background and white letters 1/4 inch high.

C. Control system shall be connected to the existing systems. All control adjustments shall be accessible without use of ladder.

D. Thermostats on outside walls shall be mounted on 1 inch rigid fiberglass insulating base.

E. All thermostat bulbs in water lines shall be installed in separable wells packed with heat-conductive compound.

3.2 DRAWINGS

A. Drawings are diagrammatic only, provide all material and labor required to make the system operate to the complete satisfaction of the Architect at no additional cost to the Owner.

B. Submit to the Architect for approval seven copies of shop drawings of the entire control system before starting work.

C. Upon completion of the work, provide diagrams of the control systems including a detailed description of the operation of the system and each component and post in the mechanical room, or as directed in a permanent frame with 1/8 inch clear plastic cover.

D. There shall be no power wiring in excess of 40 VAC peak voltages run in conduit with communications trunk wiring. In cases where power or signal wiring is run in
conduit with trunk wiring, all communication trunk wiring and power wiring shall be 
run using separate twisted shielded pairs (24 awg) with the shields grounded in 
accordance with the manufacturers wiring practices.

3.2 INSTALLATION

A. All temperature control and control interlock wiring shall be installed in plenum rated 
cable or EMT conduit per local code unless otherwise noted on the plans.

B. Wiring shall conform to the California Electrical Code.

C. The installation and supervision of this project shall be carried out by factory-trained 
personnel who are employed by the Contractor and licensed for this type of work.

D. Install in accordance with manufacturer's instructions.

E. Provide all miscellaneous devices, hardware, software, interconnections installation 
and programming required to insure a complete operating system in accordance 
with the sequences of operation and point schedules.

F. All wiring of any nature in connection with the Direct Digital Control and 
Temperature Control System, regardless of voltage, including temperature control 
wiring, interlocking branch circuits from power panels, line voltage to EMS devices 
and low voltage wiring unless shown or specified in Division 26 documents shall be 
included in this section.

G. Division 26 shall provide power wiring to equipment and signal conduit for LAN 
Wiring between buildings.

H. Division 26 shall provide underground race way conduits between buildings with a 
pull string for the Controls contractor to install direct burial communication cable 
between buildings.

3.3 AIRFLOW MEASURING STATION

A. Provide EBTRON Series Silver or equal airflow measuring station and all 
accessories. Coordinate with controls manufacturer for any requirements.

3.4 OPERATOR INSTRUCTION (Training)

A. During system commissioning and at such time acceptable performance of the 
control system hardware and software has been established; provide on-site 
operator instruction to the Owner's operating personnel. Operator instruction during 
normal working hours shall be performed by a competent representative familiar 
with systems hardware, software and accessories.

B. At a time mutually agreed upon during system commissioning, as stated above, 
provide 4 hours of training for up to 4 people after project turnover and (3) 4-hour 
sessions for up to 4 people within the first year of operation. The Owner shall 
designate personnel to attend the training.
SYSTEM SEQUENCE OF OPERATIONS AND GENERAL REQUIREMENTS:

A. ALL SYSTEM TEMPERATURES, SETPOINTS, POSITIONS, ENABLE COMMANDS, FAN SPEEDS, SCHEDULES, TRENDS, ALARMS AND STATUS SHALL BE ACCESSIBLE FROM THE DISTRICTS SERVER LOCATED AT THE MAINTENANCE OFFICE VIA REMOTE DESKTOP OR STANDARD WEB BROWSERS.

1. Points that are required to be displayed and/or controlled from the Graphical interface;
2. Supply Fan enabled
3. Supply Fan run status
4. Supply Fan speed (If ECM or VFD is provided)
5. Occupied heating and cooling set points
6. Unoccupied heating and cooling set points
7. Occupied schedules
8. Unoccupied schedules
9. Holiday and special events schedules
10. After hour override and trend duration
11. Space temperature
12. Space CO2 level
13. Economizer positioning for free cooling and demand ventilation
14. Economizer enabled and lockout temperature set points
15. Stages of heat active
16. Stages of cooling active
17. Supply air temperature
18. Economizer Fault detection and diagnostics indication
19. Morning warm-up enabled on space temperature set point
20. Morning Purge enabled on space temperature set point
21. Global Outside air temperature
22. Low ambient temperature protection

B. UNIVERSAL CONTROL STRATEGIES REQUIRED ON MOST SYSTEMS:
1. LOW AMBIENT TEMPERATURE SAFETIES WILL BE ALLOWED TO AUTO RESET 3 TIMES AND THEN BE LOCKED IN ALARM MODE BY THE DDC WITH CRITICAL ALARM SENT TO THE OPERATORS WORK STATION,
2. DURING LOW AMBIENT OUTSIDE AIR CONDITIONS ALL HOT WATER COIL VALVES ON AIR HANDLERS WILL BE OPENED 30% (ADJ.)
3. ALL ALARMS SHALL BE SENT TO DESIGNATED STAFF VIA A TEXT MESSAGE.

C. SEQUENCE OF OPERATIONS: (AC UNITS WITH HOT WATER COILS) AC-A1, AC-A2, AC-A3, AC-A4 & AC-A5

1. OCCUPIED PERIOD:
a. AT THE BEGINNING OF THE OCCUPIED PERIOD THE AC UNIT'S SUPPLY FAN WILL BE ENABLED.
2. HEATING:
   a. ON A CALL FOR HEATING THE ECONOMIZE DAMPER SHALL OPEN TO
      THE MINIMUM POSITION (ADJ.) ESTABLISHED AT THE TIME OF
      SYSTEM BALANCE.
   b. THE UNIT CONTROLLER WILL MODULATE THE HOT WATER COIL
      VALVE TO MAINTAIN A SUPPLY AIR TEMPERAURE OF 100 DEGREES
      FAHRENHEIT (ADJ.) UNTIL THE SPACE TEMPERATURE RISES TO THE
      OCCUPIED HEATING SET POINT. RESET THE SUPPLY AIR
      TEMPERATURE BASED ON ROOM TEMPERATURE LOOP OF 100
      DEGREES FAHRENHEIT AT 100% AND 70 DEGREES FAHRENHEIT AT
      0% VALVE POSITION (ADJ.). THE SUPPLY FAN WILL OPERATE
      CONTINUOUSLY DURING OCCUPIED PERIODS. IF UNIT IS EQUIPED
      WITH A SUPPLY FAN VFD, THE SUPPLY FAN WILL BE SLOWED TO 50%
      (ADJ.) OF FULL SPEED IF THE SPACE TEMPERATURE IS AT SET
      POINT.

3. COOLING:
   a. ON A CALL FOR COOLING THE CONTROL SYSTEM WILL DETERMINE IF
      THE OUTSIDE AIR IS COOL ENOUGH TO BE USED FOR FREE
      COOLING. IF CONDITIONS ARE MET FOR FREE COOLING THE
      ECONOMIZER DAMPERS WILL MODULATE OPEN UNTIL THE
      OCCUPIED COOLING SET POINT IS ATTAINED. DURING FREE
      COOLING ECONOMIZER OPERATION IF THE OCCUPIED COOLING SET
      POINT CANNOT BE ATTAINED BUT THE OUTSIDE AIR TEMPERATURE
      HAS NOT REACHED THE ECONOMIZER LOCKOUT TEMPERATURE
      (ADJ.) SECOND STAGE OF COOLING WILL BE ENERGIZED AND THE
      LEAD COMPRESSOR WITH HOT GAS BYPASS TO MAINTAIN SUPPLY
      AIR TEMPERATURE SET POINT. WHEN THE OUTSIDE AIR
      TEMPERATURE EXCEEDS THE ECONOMIZER LOCK OUT
      TEMPERATURE (ADJ.) THE ECONOMIZER DAMPERS SHALL RETURN
      TO THEIR MINIMUM POSITION. SUPPLY FAN SHALL OPERATE
      CONTINUOUSLY AT FULL SPEED. WHEN OCCUPIED COOLING SET
      POINT IS REACHED THE UNIT SUPPLY FAN VFD WILL BE SLOWED TO
      50% (ADJ.) OF FULL SPEED. STAGE 3 COOLING (WHEN AVAILABLE)
      SHALL ENERGIZE SUBSEQUENT COMPRESSORS AS DESCRIBED IN
      STAGE 2 COOLING. SUPPLY AIRFLOW SHALL BE SET TO A MINIMUM
      TO MAINTAIN 300 FEET PER MINUTE ACROSS THE DIRECT
      EXPANSION COIL.
4. DEMAND CONTROL VENTILATION:
   a. THE OUTSIDE AIR AMBIENT CO2 LEVELS WILL BE MEASURED. IF THE
      SPACE CO2 LEVELS EXCEED 1000 PPM ABOVE ASSUMED AMBIENT
      TO BE 400 PPM. THE MINIMUM OUTSIDE AIR DAMPER POSITION
      SHALL BE MODULATED TO MAINTAIN A CO2 SENSOR SETPOINT (800
      PPM, ADJUSTABLE, WITH A 200 PPM DIFFERENTIAL) AND SHALL BE
      REstricted TO MODULATE BETWEEN THE FIXED UPPER AND LOWER
      CFM LIMITS (UPPER LIMIT CFM AT 800 PPM AND LOWER LIMIT CFM AT
      600 PPM).

5. ECONOMIZER FAULT, DIAGNOSTIC AND DETECTION (FDD):
   a. DURING ECONOMIZER FREE COOLING OPERATION THE SYSTEM
      SHALL ALARM AT THE GRAPHICAL FRONT END IF THE ECONOMIZER
      DAMPERS ARE NOT RESPONDING PROPERLY TO THEIR POSITIONING
      SIGNAL AND A RED LIGHT BAR WILL SHINE BELOW THE SPACE
      SENSOR FOR LOCAL FAULT INDICATION AS REQUIRED BY TITLE 24
      ECONOMIZER FAULT DETECTION AND DIAGNOSTIC CODE
      REQUIREMENT.

6. MORNING WARM-UP: HEATING
   a. ONE HOUR (ADJ.) BEFORE OCCUPIED PERIOD BEGINS, IF THE SPACE
      TEMPERATURE IS 5 DEGREES (ADJ.) BELOW THE OCCUPIED HEATING
      SET POINT THE UNIT WILL BE ACTIVATED IN THE HEATING MODE AS
      DESCRIBED ABOVE AND OPERATE IN THIS MODE WITH SUPPLY FAN
      AT 100% SPEED UNTIL THE OCCUPIED HEATING SET POINT IS
      ATTAINED. DURING MORNING WARM-UP THE OUTSIDE AIR DAMPERS
      WILL BE FULLY CLOSED AND THE TITLE 24 REQUIRED BUILDING
      PURGE WILL BE PERFORMED DURING THE MORNING WARMUP
      CYCLE. UNIT SHALL OPERATE FOR A MINIMUM OF ONE HOUR (ADJ.)

7. MORNING PURGE: SUMMER COOLING
   a. ONE HOUR (ADJ.) BEFORE OCCUPIED PERIOD BEGINS, IF THE SPACE
      TEMPERATURE IS 5 DEGREES (ADJ.) ABOVE THE OCCUPIED COOLING
      SET POINT THE UNIT WILL BE ACTIVATED IN THE ECONOMIZER WITH
      SUPPLY FAN AT 100% SPEED AND ECONOMIZER DAMPERS FULL
      OPEN UNTIL THE OCCUPIED COOLING SET POINT IS ATTAINED. IF
      THE SPACE TEMPERATURE REACHES THE OCCUPIED COOLING SET
      POINT PRIOR TO ONE HOUR OF OPERATION THE UNIT WILL
      CONTINUE TO OPERATE BUT ECONOMIZER DAMPERS WILL RETURN
      TO MINIMUM POSITION.

8. NIGHT SET UP AND SET BACK TEMPERATURES: (THE FOLLOWING
    SEQUENCE WILL ONLY BE ACTIVE IF THE DISTRICT DETERMINES THAT
    AIR MOVEMENT DURING UNOCCUPIED PERIODS WILL NOT SET OFF THE
    INTRUSION ALARM DUE TO CURTIANS AND OTHER ITEMS MOVING.)
9. NIGHT SET UP AND SET BACK TEMPERATURES:
   a. DURING UNOCCUPIED PERIODS IF THE SPACE TEMPERATURE RISES
      ABOVE 85 DEGREES (ADJ.) OR FALL BELOW 58 DEGREES (ADJ.) THE
      UNIT WILL BE ACTIVATED IN THE HEATING OR COOLING MODE AS
      REQUIRED AND THE ECONOMIZER DAMPERS WILL REMAIN CLOSED.
      THE UNIT WILL REMAIN ON UNTIL THE SPACE TEMPERATURE RISES
      OR FALLS TO WITHIN 5 DEGREES (ADJ.) OF THE OCCUPIED HEATING
      OR COOLING SET POINT.

10. AFTER HOUR OVERRIDE OPERATION: SINGLE ZONE UNITS
    a. DURING UNOCCUPIED PERIODS IF THE OCCUPANT PUSHES A
       BUTTON ON THE SPACE TEMPERATURE SENSOR FOR AFTER HOUR
       OPERATION OF THE UNIT THE UNIT WILL SWITCH TO THE OCCUPIED
       MODE OF OPERATION. EACH PUSH OF THE BUTTON WILL ADD ½
       HOUR OF OPERATION AND TOTAL TIME WILL BE DISPLAYED ON THE
       SPACE SENSOR READ OUT DISPLAY. THE TOTAL AFTER HOUR
       USAGE TIME WILL BE PROGRAMMABLE AT THE FRONT END
       COMPUTER FROM ½ HOUR UP TO 9 HOURS. INITIAL ALLOWD
       OVERRIDE TIME WILL BE 3 HOURS (ADJ.)
    b. THE SPACE SENSOR DISPLAY WILL DISPLAY THE REMAINING AFTER
       HOUR USAGE AS IT COUNTS DOWN TO ZERO AND UNIT WILL RETURN
       TO THE UNOCCUPIED MODE OF OPERATION.

D. SEQUENCE OF OPERATIONS: (AH UNITS WITH HOT WATER COILS) AH-A1,
   AH-A2 & AH-A3

1. SAFETY CONTROLS: THE SUPPLY AIR FAN SHALL SHUT DOWN IF SMOKE
   IS SENSED BY THE SMOKE DETECTOR.

2. OCCUPIED PERIOD:
   a. AT THE BEGINNING OF THE OCCUPIED PERIOD THE AH UNIT’S
      SUPPLY FAN WILL BE ENABLED.

3. HEATING:
   a. ON A CALL FOR HEATING THE ECONOMIZER DAMPER SHALL OPEN
      TO THE MINIMUM POSITION (ADJ.) ESTABLISHED AT THE TIME OF
      SYSTEM BALANCE.
   b. THE UNIT CONTROLLER WILL MODULATE THE HOT WATER COIL
      VALVE TO MAINTAIN SPACE TEMPERATURE SETPOINT IN THE ROOM.
      THE SUPPLY FAN WILL OPERATE CONTINUOUSLY DURING OCCUPIED
      PERIODS.
4. COOLING:
   a. ON A CALL FOR COOLING THE DDC CONTROLLER SHALL MODULATE THE OUTSIDE AIR, RETURN AIR AND EXHAUST AIR ECONOMIZER DAMPERS IN A FREE COOLING MODE TO MAINTAIN ROOM TEMPERATURE SETPOINT. THE SUPPLY FAN VFD SHALL BE MODULATED TO ADMIT 50% AIR FLOW. THE RELIEF DAMPERS IN THE SPACE SHALL BE MODULATED TO MAINTAIN NO MORE THAN A .04” POSITIVE PRESSURE IN THE SPACE. THE OUTSIDE AIR, RETURN AIR AND EXHAUST AIR DAMPERS SHALL BE POSITIONED TO ALLOW MINIMUM OUTSIDE AIR FLOW AS SENSED BY THE OUTSIDE AIR FLOW MEASURING STATION WHEN THE OUTSIDE AIR RISES ABOVE 70 DEGREES FAHRENHEIT (ADJ.) OR WHEN THE OUTSIDE AIR TEMPERATURE IS HIGHER THAN RETURN AIR TEMPERATURE. THE OUTSIDE AIR MINIMUM POSITION SHALL BE RESET BY RETURN AIR OR ZONE CO2 SENSOR.
   b. DURING FREE COOLING ECONOMIZER OPERATION IF THE OCCUPIED COOLING SET POINT CANNOT BE REACHED BUT THE OUTSIDE AIR TEMPERATURE HAS NOT REACHED THE ECONOMIZER LOCKOUT TEMPERATURE (ADJ.) SECOND STAGE OF COOLING WILL BE ENERGIZED AND THE COMPRESSOR WITH HOT GAS BYPASS SHALL BE USED TO MAINTAIN SUPPLY AIR TEMPERATURE SET POINT. WHEN THE OUTSIDE AIR TEMPERATURE EXCEEDS THE ECONOMIZER LOCK OUT TEMPERATURE (ADJ.) THE ECONOMIZER DAMPERS SHALL RETURN TO THEIR MINIMUM POSITION. SUPPLY FAN SHALL OPERATE CONTINUOUSLY AT FULL SPEED. WHEN OCCUPIED COOLING SET POINT IS REACHED THE UNIT SUPPLY FAN VFD WILL BE SLOWED TO 80% (ADJ.) OF FULL SPEED. SUPPLY AIRFLOW SHALL BE SET TO A MINIMUM TO MAINTAIN 300 FEET PER MINUTE ACROSS THE DIRECT EXPANSION COIL.

5. DEMAND CONTROL VENTILATION:
   c. THE OUTSIDE AIR AMBIENT CO2 LEVELS WILL BE MEASURED. IF THE SPACE CO2 LEVELS EXCEED 1000 PPM ABOVE ASSUMED AMBIENT TO BE 400 PPM. THE MINIMUM OUTSIDE AIR DAMPER POSITION SHALL BE MODULATED TO MAINTAIN A CO2 SENSOR SETPOINT (800 PPM, ADJUSTABLE, WITH A 200 PPM DIFFERENTIAL) AND SHALL BE RESTRICTED TO MODULATE BETWEEN THE FIXED UPPER AND LOWER CFM LIMITS (UPPER LIMIT CFM AT 800 PPM AND LOWER LIMIT CFM AT 600 PPM).

6. ECONOMIZER FAULT, DIAGNOSTIC AND DETECTION (FDD):
   a. DURING ECONOMIZER FREE COOLING OPERATION THE SYSTEM SHALL ALARM AT THE GRAPHICAL FRONT END IF THE ECONOMIZER DAMPERS ARE NOT RESPONDING PROPERLY TO THEIR POSITIONING SIGNAL AND A RED LIGHT BAR WILL SHINE BELOW THE SPACE SENSOR FOR LOCAL FAULT INDICATION AS REQUIRED BY TITLE 24 ECONOMIZER FAULT DETECTION AND DIAGNOSTIC CODE REQUIREMENT.
7. MORING WARM-UP: HEATING
   a. ONE HOUR (ADJ,) BEFORE OCCUPIED PERIOD BEGINS, IF THE SPACE TEMPERATURE IS 5 DEGREES (ADJ,) BELOW THE OCCUPIED HEATING SET POINT THE UNIT WILL BE ACTIVATED IN THE HEATING MODE AS DESCRIBED ABOVE AND OPERATE IN THIS MODE WITH SUPPLY FAN AT 100% SPEED UNTIL THE OCCUPIED HEATING SET POINT IS ATTAINED. DURING MORNING WARM-UP THE OUTSIDE AIR DAMPERS WILL BE OPENED TO THEIR MINIMUM SETTINGS TO ACCOMPLISH TITLE 24 REQUIRED BUILDING PURGE DURING THE MORNING WARMUP CYCLE. UNIT SHALL OPERATE FOR A MINIMUM OF ONE HOUR (ADJ.)

8. MORNING PURGE: SUMMER COOLING
   d. ONE HOUR (ADJ,) BEFORE OCCUPIED PERIOD BEGINS, IF THE SPACE TEMPERATURE IS 5 DEGREES (ADJ,) ABOVE THE OCCUPIED COOLING SET POINT THE UNIT WILL BE ACTIVATED IN THE ECONOMIZER WITH SUPPLY FAN AT 100% SPEED AND ECONOMIZER DAMPERS FULL OPEN UNTIL THE OCCUPIED COOLING SET POINT IS ATTAINED. IF THE SPACE TEMPERATURE REACHES THE OCCUPIED COOLING SET POINT PRIOR TO ONE HOUR OF OPERATION THE UNIT WILL CONTINUE TO OPERATE BUT ECONOMIZER DAMPERS WILL RETURN TO MINIMUM POSITION.

9. NIGHT SET UP AND SET BACK TEMPERATURES: (THE FOLLOWING SEQUENCE WILL ONLY BE ACTIVE IF THE DISTRICT DETERMINES THAT AIR MOVEMENT DURING UNOCCUPIED PERIODS WILL NOT SET OFF THE INTRUSION ALARM DUE TO CURTAINS AND OTHER ITEMS MOVING.)

10. NIGHT SET UP AND SET BACK TEMPERATURES:
    a. DURING UNOCCUPIED PERIODS IF THE SPACE TEMPERATURE RISES ABOVE 85 DEGREES (ADJ,) OR FALL BELOW 58 DEGREES (ADJ,) THE UNIT WILL BE ACTIVATED IN THE HEATING OR COOLING MODE AS REQUIRED AND THE ECONOMIZER DAMPERS WILL REMAIN CLOSED. THE UNIT WILL REMAIN ON UNTIL THE SPACE TEMPERATURE RISES OR FALLS TO WITHIN 5 DEGREES (ADJ,) OF THE OCCUPIED HEATING OR COOLING SET POINT.

11. AFTER HOUR OVERRIDE OPERATION: SINGLE ZONE UNITS
    a. DURING UNOCCUPIED PERIODS IF THE OCCUPANT PUSHES A BUTTON ON THE SPACE TEMPERATURE SENSOR FOR AFTER HOUR OPERATION OF THE UNIT THE UNIT WILL SWITCH TO THE OCCUPIED MODE OF OPERATION. EACH PUSH OF THE BUTTON WILL ADD ½ HOUR OF OPERATION AND TOTAL TIME WILL BE DISPLAYED ON THE SPACE SENSOR READ OUT DISPLAY. THE TOTAL AFTER HOUR USAGE TIME WILL BE PROGRAMMABLE AT THE FRONT END COMPUTER FROM ½ HOUR UP TO 9 HOURS. INITIAL ALLOWD OVERRIDE TIME WILL BE 3 HOURS (ADJ.)
b. THE SPACE SENSOR DISPLAY WILL DISPLAY THE REMAINING AFTER HOUR USAGE AS IT COUNTS DOWN TO ZERO AND UNIT WILL RETURN TO THE UNOCCUPIED MODE OF OPERATION.

E. IDEC-L1 & IDEC-L2 (WITH HOT WATER HEATING):

1. THE CONTROL SYSTEM SHALL ENERGIZE THESE UNITS DURING OCCUPIED PERIODS. THE SUPPLY FAN SHALL OPERATE AT 100% SPEED DURING OCCUPIED PERIODS. WHEN THE UNITS ARE ACTIVATED THE UNIT’S OUTSIDE AIR DAMPER SHALL BE PROVEN OPEN BY AN END SWITCH BEFORE THE SUPPLY FAN IS ENERGIZED. WHEN HEAT IS REQUIRED THE CONTROLLER WILL MODULATE THE HOT WATER COIL VALVE TO MAINTAIN OCCUPIED HEATING SET POINT. WHEN COOLING IS REQUIRED THE CONTROL WILL FIRST ENERGIZE THE INDIRECT EVAPORATIVE COOLING SECTION FAN, PUMPS AND SCAVENGER FANS. IF THE SPACE COOLING TEMPERATURE SET POINT CANNOT BE MAINTAINED WITH INDIRECT EVAPORATIVE COOLING THEN THE DIRECT EVAPORATIVE COOLING SECTION WILL BE ENERGIZED.

F. IDEC-G1A & IDEC-G1B (WITH NATURAL GAS HEATING):

1. THE CONTROL SYSTEM SHALL ENERGIZE THESE UNITS DURING OCCUPIED PERIODS. THE SUPPLY FAN SHALL OPERATE AT MINIMUM SPEED TO MAINTAIN THE MINIMUM OUTSIDE AIR VENTILATION SHOWN IN THE SCHEDULE. THE MAXIMUM HEAT AND COOLING SPEED SHALL PROVIDE THE SUPPLY AIRFLOW EQUAL TO THE DESIGN HEATING AND COOLING AIRFLOW IN THE SCHEDULE.

2. WHEN THE UNITS ARE ACTIVATED THE UNIT’S OUTSIDE AIR DAMPER SHALL BE PROVEN OPEN BY AN END SWITCH BEFORE THE SUPPLY FAN IS ENERGIZED.

3. ON CALL FOR HEAT AS SENSED BY ROOM TEMPERATURE SENSOR, THE CONTROLLER WILL MODULATE THE GAS FURNACE TO MAINTAIN OCCUPIED HEATING SET POINT.

4. ON CALL FOR COOLING, FIRST STAGE COOLING, THE DDC CONTROLLER SHALL MODULATE THE RETURN AIR, OUTSIDE AIR AND EXHAUST FAN IN A FREE COOLING MODE TO MAINTAIN ROOM TEMPERATURE. THE SUPPLY FAN VFD SHALL MODULATE TO ADMIT 50% AIRFLOW. THE EXHAUST FAN VFD SHALL BE MODULATED TO TRACK THE SUPPLY AIR FLOW AS SENSED BY THE SUPPLY AND EXHAUST AIR FLOW MEASURING STATIONS. THE OUTSIDE AIR AND RETURN AIR DAMPERS AND EXHAUST FAN SHALL BE OPERATED TO ADMIT MINIMUM OUTSIDE AIR AS SENSED BY THE OUTSIDE AIR FLOW MEASURING STATION WHEN THE OUTSIDE AIR RISES ABOVE TO 70 DEGREES FAHRENHEIT (ADJ). THE OUTSIDE AIR MINIMUM SHALL BE RESET BY MINIMUM AIRFLOW LISTED.
5. ON FURTHER CALL FOR COOLING, THE RETURN AIR DAMPERS, OUTSIDE AIR DAMPERS AND EXHAUST FAN SHALL CONTINUE TO OPERATE AS DESCRIBED ABOVE AND SECOND STAGE COOLING (INDIRECT EVAPORATIVE COOLING) SECTION SHALL BE STARTED. IF THE SPACE COOLING TEMPERATURE SET POINT CANNOT BE MAINTAINED WITH INDIRECT EVAPORATIVE COOLING THEN THE THIRD STAGE COOLING (DIRECT EVAPORATIVE COOLING) SECTION WILL BE STARTED.

6. DEMAND CONTROL VENTILATION:
   a. THE OUTSIDE AIR AMBIENT CO2 LEVELS WILL BE MEASURED. IF THE SPACE CO2 LEVELS EXCEED 1000 PPM ABOVE ASSUMED AMBIENT TO BE 400 PPM. THE MINIMUM OUTSIDE AIR DAMPER POSITION SHALL BE MODULATED TO MAINTAIN A CO2 SENSOR SETPOINT (800 PPM, ADJUSTABLE, WITH A 200 PPM DIFFERENTIAL) AND SHALL BE RESTRICTED TO MODULATE BETWEEN THE FIXED UPPER AND LOWER CFM LIMITS (UPPER LIMIT CFM AT 800 PPM AND LOWER LIMIT CFM AT 600 PPM).

G. FAN COIL UNITS:

1. SPLIT SYSTEM FAN COILS SHALL OPERATE ON THEIR OWN FACTORY CONTROLS AND SPACE TEMPERATURE SENSOR. A SEPARATE STAINLESS STEEL SENSOR SHALL BE INSTALLED IN THE SPACE SERVED BY THE FAN COIL AND WIRED TO THE NEAREST CONTROLLER AND PROGRAMMED TO SEND AN ALARM IF THE SPACE TEMPERATURE RISES ABOVE 80 DEGREES (ADJ.)

H. EXHAUST FANS:

1. SEE EQUIPMENT SCHEDULE ON CONTROL DRAWINGS FOR EXHAUST FAN INTERLOCKS REQUIREMENTS.

I. HOT WATER HEATING SYSTEM:

1. THE HEATING SYSTEM WILL BE ENABLED WHENEVER THERE IS A CALL FOR HEAT DURING MORNING WARM-UP AND OCCUPIED PERIODS. THE OWNER SHALL HAVE THE CAPABILITY TO LOCK OUT THE HEATING PLANTS DURING THE WARM DAYS OF SPRING AND SUMMER.
   a. WHEN THERE IS A CALL FOR HEATING AND THE OUTSIDE AIR TEMPERATURE IS BELOW THE HEATING LOCKOUT TEMPERATURE 68 DEGREES (ADJ.) THE BOILER SHALL BE ENERGIZED AND THE ASSOCIATED PUMP SHALL BE ENERGIZED. THE BOILER WILL OPERATE ON IT OWN CONTROLS. THE BOILER SHALL MAINTAIN THE HOT WATER LOOP SUPPLY TEMPERATURE OF 160 DEGREES (ADJ).
2. BOILER RESET:
   a. 160° F - 32° F AMBIENT
   b. 140° F - 45° F AMBIENT
   c. 120° F - 60° F AMBIENT
   d. All of these are adjustable set points.

J. SAFETIES:

1. THE DUCT SMOKE DETECTOR SHALL DISABLE ALL AIR HANDLERS, AC UNITS, FAN COIL UNITS ETC. SUPPLYING MORE THAN 2000 CFM OR IF THE COMBINED AIRFLOW BETWEEN SEVERAL UNITS IS MORE THAN 2000 CFM.
2. THE FILTER PRESSURE DROP SENSOR SHALL INDICATE AN ALARM CONDITION WHENEVER THE FILTER PRESSURE DROP EXCEEDS SETPOINT (.75" W.G.)

END OF SECTION 23 09 23
SECTION 23 11 23
FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Section 23 05 00 applies to this section.

1.2 SUMMARY

A. This section includes all plumbing (equipment, fixtures, pipe and fittings, specialties) inside the building(s) and outside the building(s) to the point of connection to site plumbing systems.

B. Provide complete plumbing systems including:

1. Service connections to existing on-site utilities, and stubs for future connection to equipment provided under the work of this Section or other Sections of the Specifications.

2. All piping systems for conduction of natural gas as shown or specified for plumbing work.

3. All valves, piping supports, piping penetration auxiliaries, piping protective coverings, piping, and other piping accessories as shown or specified for plumbing work.

4. All plumbing equipment and auxiliary items as specified herein or shown on the drawings.

1.3 RELATED SECTIONS

A. Section 23 00 00 - HVAC

B. Section 23 07 00 - Insulation

C. Section 21 00 00 - Fire Protection

D. Section 22 00 00 - Plumbing

1.4 QUALITY ASSURANCE

A. All plumbing fixtures and equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.

1.5 REFERENCES

A. Pipes and Tubes

1. Steel Pipe: ASTM A53, Type S, Grade A, Schedule 40, seamless, black or galvanized, plain ends.


B. Fittings


3. Polyethylene Plastic: ASTM D2683 and D3261, socket or butt fusion fittings.

1.6 JOINING MATERIALS

A. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

B. Heat Fusion

1.7 STRUCTURAL REQUIREMENTS

A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer and approval from DSA. Where possible, offset vents and pipes rising in walls, concealed above ceilings, below plates and rise through roof. Where this is not possible, install vents and pipes through plates as detailed on structural drawings.

1.8 SUBMITTALS

A. Submit a general statement of materials and methods along with manufacturer’s technical data and installation instructions for all equipment, fixtures, pipe and fittings, and plumbing specialties to be installed.

B. Record Drawings: Per specification section 23 05 00 requirements.

C. Operation and Maintenance Manuals: Per specification section 23 05 00 requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Adapters: Wrought copper male adapters shall be used wherever it is necessary to connect copper tubing to a valve or "tee" having threaded connections.

2.2 PIPE, FITTING, AND JOINING MATERIALS

A. Steel/Threaded Fittings

1. Pipe: Black or galvanized steel per ASTM A-53 seamless, threaded ends, standard weight Schedule 40 or Schedule 80.

2. Fittings:

a. Black or galvanized (to match pipe) banded malleable iron, threaded, ASTM A-197, 150 lb. standard or 300 lb. extra heavy per ANSI Standard B16.3 (to match pipe schedule).

b. Black or galvanized (to match pipe) banded cast iron, threaded, per ASTM A-126 Class B, 125 lb. standard or 250 lb. extra heavy per ANSI Standard B16.4 (to match pipe schedule).

c. Unions: AAR 300 lb. malleable iron, black or galvanized (to match pipe).

d. Joining Materials/Methods

1) Rectorseal or pure lead and graphite thread lubricant.
2) Permacel, P-412, ½" wide teflon pipe joint sealant.

B. Steel/Welding Fittings
   1. Fittings: Black steel, permanently marked, seamless butt welding type, standard weight or extra strong (to match pipe schedule). Optional in lieu of tees where main is at least two pipe sizes larger than branch Bonney Forge, Threadolets for ½" to 2", weldolets for branch lines 2 ½" to 4"; fitting shall suit main size.
   2. Unions: AAR 300 lb. malleable iron, black or galvanized (to match pipe).
   3. Joining Materials/Methods
      a. Gas or electric arc welding per ASME Code for pressure piping.

C. Polyethylene plastic butt fusion welded joints
   1. Pipe: Schedule 40, plain ends.
   2. Fittings: Polyethylene fusion welded type.
   4. Connections: Utilize only adapters supplied by the same manufacturer of the pipe.

2.3 PIPE AND FITTING APPLICATIONS

A. Inside Building (to 5'-0" outside building line).
   1. Gas Piping: Schedule 40, black steel pipe; malleable iron screwed fittings for sizes 2" and smaller. Weld sizes 2 ½" and larger. Weld all below grade piping and protect as specified herein.
   2. Plastic pipe and fittings shall not be used inside of buildings.

B. Outside Building (from 5'-0" outside building line)
   1. Gas piping
      a. Above grade and to 30" below grade, shall be Schedule 40, black steel pipe with 150 lb. malleable iron, welded joints.
      b. Below grade pipe shall be protected with X-Tru-Coat and fittings covered with X-Tru-Coat, heat shrink, sleeves to 6" above grade. Above grade sizes 2" and smaller may be screwed joints.
      c. Underground gas piping below 30" depth and 30" after the first change in direction, shall be polyethylene pipe with fusion welded joints.

2.4 PIPE PROTECTION

A. Bare galvanized or black steel pipe buried in the ground shall have a corrosion protective wrap of one of the following:
   1. Polyvinyl Chloride Tape: The tape shall be of a minimum thickness of 10 mils and shall be laminated with a suitable adhesive, or shall be applied with a suitable primer adhesive. Width as recommended by the manufacturer for the pipe sizes being wrapped (4" minimum). Tape shall have continuous identification
   2. 3M X-Tru-Coat, factory-applied plastic coating with additional field-applied double-layer wrapping of Scotchrap #51, 20-mil plastic tape, Trentex No. V-10, B-20, Scotchwrap No. 50 Polyvinyl chloride tape wrap, or thermofit sleeves.
3. Field Joint Cover: Tape coat, prime coat and one layer of Tape coat #20 heat-applied 62-mil tape.

B. Provide a sacrificial anode for the underground portion of all steel piping when required by the local authority.

2.5 VALVES

A. General

1. Furnish two tee handle operators for each size to suit all valves which are installed below grade in access boxes and which are not fitted with integral handles; hub end valves shall be used where required.

2. Valves on systems operating over 100 psi shall be rated for 150 lb. or higher as required.

B. Shut-off service, domestic water

1. Ball Valves:
   a. Sizes 3" and smaller: Nibco 585, 400 psi rated, threaded or sweat ends, full port, teflon seat, quarter turn handle with stops, two piece bronze body.

C. Shut-off service, natural gas

1. Sizes 2" and smaller: NibcoT-585-70-UL, full port ball valve; 400 psi gas service rating; bronze body and ball, teflon seat, quarter turn handle with stops, swing-out accessibility/removal.

2. Sizes 2 1/2" to 4": DeZurik Fig. 425, 175 psi shut-off pressure differential; semi-steel body, threaded ends, eccentric plug with RS-49 facing, Fig. 483 lever handle.

2.6 PIPING ACCESSORIES

A. Unions shall have the same pressure rating as pipe fittings.

2.7 PIPING PENETRATION AUXILIARIES

A. Sleeves Below Slab or Grade: Metraseal model MS or equal with schedule 80 PVC sleeve. The seal shall be capable of withstanding a hydrostatic pressure of 20 psig. The seal shall be constructed of synthetic rubber with heavy-duty plastic pressure plates. All bolts and nuts shall be constructed of stainless steel.

B. Escutcheons: Polished chrome plated brass or painted metal.

PART 3 - EXECUTION

3.1 GAS PIPING

A. Gas Piping: Install generally level with as few bends as possible. Install dirt legs and shut-off valves at each piece of equipment. Support as specified and in accordance with the C.P.C.

B. Polyethylene Gas Piping: Shall be heat fusion welded in strict accordance with manufacturer's installation instruction. Bury high pressure mains (over 7" W.C.) 36" minimum and low pressure (7" W.C. or less) 30". Place pipe on 6" sand bed on trench bottom and cover pipe with 12" sand after placement. Remaining backfill may be native soil.
C. Bury a No. 18 AWG insulated copper locating wire with all non metallic pipe. Copper wire shall have at least 12" above grade at each end.

3.2 VALVES

A. Valves shall be full size of line in which installed. Furnish discs suitable for service intended. All valves shall be properly packed and lubricated. Unions shall be placed adjacent to each threaded or soldered valve or equipment connection 2" and smaller. Install flanges at all valves with stems vertical wherever possible. Stems shall not be placed below horizontal.

B. Install unions adjacent to each valve and at final connection to each piece of equipment.

C. All shutoff valves in gas lines shall be or ball valves, unless otherwise shown.

D. Valves shall be provided with brass identification tags indicating service controlled. Tags may be omitted on lines exposed in equipment rooms where service is obvious.

3.3 PIPING TESTING: TESTING CRITERIA

<table>
<thead>
<tr>
<th>System</th>
<th>Medium</th>
<th>Pressure</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>Air</td>
<td>150 psig above grade</td>
<td>12 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65 psig below grade</td>
<td>12 hours</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. All Sections of Division 23

1.2 SUMMARY
A. Work Included
   1. Provide complete piping systems for conduction of heating hot water supply and return, chilled water supply and return, and other fluids for HVAC work including all other chemicals required for pipe flushing, cleaning, testing, etc., all as specified or shown on the drawings.
   
B. Provide all valves, strainers, piping supports, seismic braces, piping penetration auxiliaries, protective coverings, piping insulation, and other piping appurtenances as shown or specified for HVAC work.

C. Installation of sensing and control devices that mount on or insert into piping, see 23 05 19, 23 05 23 and 23 09 13.

1.3 QUALITY ASSURANCE
A. All HVAC equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.

B. Standards: Comply with all applicable codes or standards governing process piping, system materials, application, and installation.

C. Welding Qualifications: Welders shall be certified in accordance with American Welding Society "Standard Qualification Procedure".

1.4 REFERENCES
A. Pipes and Tubes
   4. Copper Drainage Tube: ASTM B 306, Type DWV, drawn temper.
   5. Fittings

B. Joining Materials
1. Pipe Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
2. Solder Filler Metal: ASTM B 32, alloys to suit system requirements.
3. Brazing Filler Metals: AWS A5.8, alloys to suit system requirements.
4. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

1.5 SUBMITTAL
A. Testing, Adjusting, and Balancing Agency Qualifications: AABC or NEBB certified.

1.6 STRUCTURAL REQUIREMENTS
A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer and approval from DSA.

PART 2 - PRODUCTS
2.1 PIPE MATERIALS
A. Copper/Soldered Joints
1. Pipe: Type L, Type K or Type M hard drawn copper tubing per ASTM B-88, plain ends.
2. Fittings: Solder type, wrought copper per ANSI Standard B15.22 or cast red bronze per ANSI Standard B16.18. Do not use T-drill.
3. Unions: Solder type, cast red bronze.
4. Joining Materials/Methods
   a. Canfield, Silvabrite or equal lead free solder with a non-corrosive water based flux;

B. Steel/Threaded Fittings
1. Pipe: Black or galvanized steel per ASTM A-53, threaded ends, standard weight Schedule 40 or extra heavy Schedule 80.
2. Fittings: Black or galvanized (to match pipe) banded malleable iron, threaded, ASTM A-197, 150 lb. standard or 300 lb. extra heavy per ANSI Standard B16.3 (to match pipe schedule).
   a. As an alternate, black or galvanized (to match pipe) banded cast iron, threaded, per ASTM A-126 Class B, 125 lb. standard or 250 lb. extra heavy per ANSI Standard B16.4 (to match pipe schedule).
3. Unions: AAR 300 lb. malleable iron, black or galvanized (to match pipe).
4. Joining Materials/Methods
   a. Rectorseal or pure lead and graphite thread lubricant.
   b. Permacel, P-412 ½" wide teflon pipe joint sealant.
   c. Other Services: Use Armite Joint Seal compound No. 250 or Enterprise Commercial Thread-Seal.

C. Steel/Flanged Fittings
   1. Pipe: Black or galvanized steel per ASTM A-53 plain ends.
      a. Size 8" and smaller: Standard weight schedule 40, schedule 80.
      b. Size 10": Standard weight schedule 40, schedule 60.
      c. Size 12" and larger: Standard in accordance with ANSI B36.10 and B36.19 pipe schedule designations.

   2. Fittings: Black or galvanized (to match pipe), cast-iron flanged per ASTM A-126, Class B, 125 lb. standard or 250 lb. extra heavy per ANSI Standard B16.1 (to match pipe schedule).

   3. Unions, Fitting Connections: Threaded, flanged, matched to fitting.

   4. Joining Materials/Methods
      b. Flange bolts - American National Standard regular galvanized square or hex head bolts and galvanized heavy cold-pressed hex nuts.

D. Steel/Welding Fittings
   1. Pipe: Black steel per ASTM A-53, plain ends, standard weight as specified for PP-4 (2.1.4.1 this Section).

   2. Fittings: Black steel, permanently marked, seamless butt welding type, standard weight or extra strong (to match pipe schedule). Optional in lieu of tees where main is at least two pipe sizes larger than branch Bonney Forge, Threadlets for ½" to 2", weldolets for branch lines 2 ½" to 4"; fitting shall suit main size.

   3. Joining Materials/Methods
      a. Gas or electric arc welding per ASME Code for pressure piping.
          1) Welded Pipe: Welds - Single V butt weld - beveled pipe ends for sizes 2 ½" and larger. Socket welds for sizes up to and including 2".

2.2 PIPING

A. Heating Hot Water above ground
   1. Size 2" and smaller: Use type L, Copper, silver brazed joints.
   2. Size 2 ½" to 4": Use type L, Copper, silver brazed joints or steel/flanged fittings or steel/welded fittings.
   3. Size 6" and larger: Use steel/flanged fittings or steel/welded fittings, Schedule 40, black iron for sizes up through 10".
   4. Grooved fittings shall not be used.
2.3 PIPING AUXILLARIES

A. Piping Flexible Connectors
   2. The body shall be reinforced with rectangular or round body rings and a minimum of six bias plies of polyester fabric.
   3. An acrylic coating shall be applied completely and uniformly to the cover.
   4. All expansion joints shall be rated for 140 psi, 26" vacuum at 250 degrees F for sizes up to and including twelve inches in diameter.
   5. Provide 3/8" thick galvanized flat, not L shaped, backup rings and control rods with a rubber bushing to eliminate metal to metal contact to eliminate axial extension.
   6. All expansion joints shall be domestically manufactured.
   7. The manufacturer shall provide documentation utilizing oven aged and cold flexibility tests to verify elastomer capability.
   8. Metallic Piping System (140°F and above): Hyspan 5501R 3 ply 304 stainless steel bellows, Flexonics model TCS-R or equal. 304L Stainless Steel bellows rated for 150 psi, 750°F.
   10. Others as specified in other piping sections or shown on drawings.

B. Piping Flexible Hose
   1. Flexible connections in refrigerant lines and other high temperature lines shall be stainless steel hose and braid with carbon steel fittings.
      a. Connectors two inches and diameter or less shall use male threaded nipples.
      b. Connectors greater than 2 inches in diameter shall be flanged.
      c. Hoses shall be suitable for operating temperatures up to 500°F.
      d. All metal flexible connectors shall have a certified helium leak test and hydrotest to maximum rated system test pressure.

2.4 STRainers

A. Y-Type, Armstrong
   1. Sizes 2" and smaller: 250 psi bronze body, threaded or soldered ends, threaded screen retainer. monel screen with .045" perforations.
   2. Sizes 2 ½" and larger: 125 psi body, 125 lb. flanged or grooved ends, bolted screen retainer. monel screen with .045" perforations.

B. Basket Type: Sarco, No. 528 with bolted cover and stainless steel basket.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Powder-actuated-type, drive-pin attachments with pullout and shear capacities appropriate for supported loads and building materials, UL listing and FM approval for fire-protection systems. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of
piping. Provide beam clamp retaining straps for all pipe supports where attached to steel beams.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pullout and shear capacities appropriate for supported loads and building materials.

C. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

D. B-Line, finish: Electro-Chromate or hot dipped galvanized.
   1. Individual: B3690, B3100 cleavis or B3110
      a. Use H-104 all thread rod.
      b. Use B3110 for pipe subject to movement.
   3. For insulated pipe - B3690 pipe hangers sized to allow pipe insulation to pass continuously through the hanger.
      a. Trapeze Supporting Rods: Diameter sufficient to support the load with a safety factor of 5.
      b. Isolators: 319CT or Trisolator.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS

A. General:
   1. Provide trenching and backfill for buried piping and install with the following minimum cover unless shown otherwise, cover is from top of pipe to finish grade. Place pipe on 6" sand bed on trench bottom and cover pipe with 12" sand after placement. Remaining backfill may be native soil.
      a. Hot Water Pipe 30"
   2. Install piping level, plumb, and parallel to structure line except where shown otherwise or required by function or regulation to be angled or sloped.
   3. Install the piping systems to present a neat appearance both as to workmanship and grouping.
   4. Install all piping free of traps or unnecessary bends, arranged to conform to building requirements, and to suit the necessities of clearance for other mechanical work such as ducts, flues or conduits.
   5. Use reducing fittings where any change in pipe size occurs. Bushings shall not be used. Use eccentric reducing fittings wherever necessary to provide free drainage or air elimination.
   6. Install piping concealed within spaces provided in the structure unless specifically noted to be exposed.
   7. Install piping without bending, springing, forcing, or placing undue stress on the pipe, fittings, connected equipment, or terminals.
   8. Install piping to allow for expansion, contraction, and structural settlement. See 23 05 16.
9. Pipe guides shall be installed per the manufacturer's recommendations. Two guides are required on each side of the joint when joint is installed in the middle of the pipe run.

10. Install piping so it does not directly contact the structure except where shown or specified otherwise.

11. The contractor shall provide all miscellaneous metal as required to attach the pipe support to structure. As an alternate, piping may be supported from the roof deck if approved by the owner and structural engineer.

12. Contractor is responsible for full compliance.

13. Expansion: Install piping with sufficient offsets, loops, and/or swing joints to allow for expansion and contraction. Anchor piping at equipment to restrain movement at those locations.

14. Install piping so that it does not interfere with equipment access.

15. Provide for drainage of lines and elimination of air.

16. Furnish and install manual air vent at high points of water systems including all coil piping and at any other points necessary to free systems of air. Locate within 7'-0" of floor.

17. Flush each piping system thoroughly clean before connecting to apparatus or equipment.

18. Paint all exposed piping:

19. Colors to be approved by the architect, or to match existing pipe colors.

20. Pipe Sizing
   a. Pipe sizes shown are nominal. Should size not be shown, or erroneously shown undersized for any intermediate section of piping run, install pipe of the same size as the largest pipe connecting to the section in question.
   b. Run full pipe size through shutoff valves, balancing valves, etc. Change pipe size within three pipe size diameters of final connection to temperature control valves, coils and other equipment.

B. Drains: Install drain with a valve at low points of all hydronic systems; line size up to 2" pipe, 2" for pipes larger than 2" size.

C. Condensate Drain: Provide for all drain pans including those for cooling coils. Route condensate drain to nearest drain, or to location shown on drawings.

D. Flashing: Flash piping penetrations of exterior walls. Install escutcheons.

E. Piping Miscellaneous
   1. Provide unions at connections to equipment, on service side of valves, and elsewhere as required to facilitate maintenance.
   2. Provide dielectric connectors between dissimilar metals.
   3. Victaulic Style 47 Dielectric water way for grooved piping systems.
   4. Provide brass-piping connection of copper tubing to threaded terminals or equipment.
   5. Use eccentric reducers only to keep top of water pipes level.
   6. Connect water branches to provide for air elimination.
   7. Grade water piping continuously up to air vent connections.
F. Sleeves
1. Install sleeves of sufficient size to allow for free motion of pipe.
2. Where pipes penetrate walls or slabs, install sleeves of 10 gauge galvanized steel pipe.
3. Finishes sleeves flush when in walls and extend a minimum of 2" above floor when passing through floor slabs and outside walls shall be caulked with oakum and mastic and made watertight.
4. No visible leakage at sleeves will be permitted.
5. Sleeve all pipes where pipes pass through footings with 18 gauge Galvanized Iron or PVC pipe sleeves.
6. Fire-Barrier Penetrations: Seal pipe penetrations with firestopping sealant material specified in Division 7.
7. Cathodic Protection
   a. Install insulated flanges or dielectric unions at points of connection between pipes and equipment as follows:
      1) Between copper or brass piping and steel or cast iron pipe.
      2) Between copper or brass piping and any steel material.

3.2 EXCAVATING AND TRENCHING

A. Perform all excavations as required for the installation of the work included under this section, including shoring of earth banks to prevent cave-ins and to protect workmen and equipment. Restore all surfaces, roadways, walks, curb, walls, existing underground installations, etc. damaged or cut as a result of the excavations to their original conditions in a manner approved by the architect. Excavations shall be ample in size to permit pipes or equipment to be laid at elevations intended, and to permit ample space for caulking and joining and compacting backfill around pipe. Maintain all warning signs, barricades, flares and red signal lanterns as required by the Safety Orders of the Division of Industrial Safety and local ordinances. Perform all pumping required to remove all water from trenches during installation of piping and backfilling.

B. Stop machine excavation for pipe trenches in solid ground, several inches above required grade, so that a firm and uniform bearing throughout entire length of pipe is provided. In lieu of above hand excavation on bottom of trench, the contractor may excavate to a depth one quarter of the nominal diameter of pipe, but in no case excavate less than 6" below required grade line, and place a bed of sand or granular soil, properly compacted to provide a uniform grade and to provide a firm support for pipe throughout its entire length. When pipe or underground conduit with insulation or protective coating is to be placed in the trench, clean sand only shall be used for bedding the pipe or conduit.

3.3 BACKFILLING

A. No backfilling operations shall begin until the required tests and inspections have been made and approval for backfilling has been given by the Architect. Should any of the work be enclosed or covered up before it has been approved, contractor shall, at his expenses, uncover the work. After it has been inspected, tested and approved, he shall make all repairs necessary to restore the work of the other contractor to the condition in which it was found at the time of uncovering. Insulated pipe and pipe with protective coating shall be backfilled with clean, concrete grade sand for a minimum distance of 12" above the top of
the pipe. Compact sand backfill by flooding or jetting. Protect pipe from uplift during jetting operation.

B. Except under existing paved areas, walks, roads, or similar surfaces, and in cases where rock is encountered, backfill more than 12" above the top of the pipe shall be made using suitable excavated material or other approved material as necessary. The backfill shall be placed in 6" layers, measured before compaction, and tamped either by hand or machine.

C. Machine tamping of backfill for excavations under existing or proposed pavement, walks, roads or similar surfaces, and under new slabs on grade, shall be made in accordance with division 02222. Backfill for excavation under pavement, slabs, walks, roads and similar surfaces shall be compacted as specified in division 02222. Surface work shall be replaced to match the existing work. Replace or repair to its original condition all sod, concrete, or other materials disturbed by the trenching or backfilling operation. Remove and dispose of all excess material.

3.4 CROSSING EXISTING UTILITIES

A. Extreme care shall be exercised during excavation across existing utility lines particularly gas and electrical lines for trenching to install new utility lines. Hand excavate all trenches in the proximity of existing lines so as not to damage or cut into them.

B. All existing utility and service lines shall be located by hand excavation prior to trenching with equipment.

C. The location, depth and invert elevations of all existing utilities to be crossed or to which connecting shall be determined before performing any other work or ordering any materials for the project.

3.5 PIPE JOINTS AND CONNECTIONS

A. Cutting: Cut pipe and tubing square with a circular cutting machine, chain or other appropriate sharp cutters only and ream ends after cutting. Do not saw.

B. Fit piping and make changes of size or direction only with proper manufactured fittings; do not bend pipe or use job fabricated fittings, street ells, bushings, reducing flanges, or close nipples.

C. Threaded Pipe: Place joint compound carefully and smoothly on male thread and not in fitting. Make threaded joints tight with tongs or wrenches. Caulking of any kind will not be permitted. Remake leaky joints with new materials. Use of thread cement caulking to make end joint tight is absolutely prohibited. Use only American Standard Pipe threads. Cut all threads accurately, not more than two threads shall show beyond fitting.

D. Copper and Brass Pipe: Clean surfaces to be joined of oil, grease, rust and oxides. Remove grease from fittings by applying carbon tetrachloride with a brush. Clean socket of fitting and end of pipe thoroughly with crocus cloth to remove rust and oxides. After cleaning and before assembly or heating, apply Handy or Airosil Flux to each joint surface and spread evenly. Apply heat with an oxyacetylene torch. Make joints in accordance with instructions in bulletin 17, published by Handy and Harmon Company, or Air Reduction Catalog No. 925. Exercise extreme care to prevent overheating of pipe and fittings. Do not use sharp-tooth wrench in making up brass pipe. Use friction wrenches exclusively when erecting plated, polished, or soft-metal piping.
E. Welded Pipe: Make-up with oxyacetylene or electric arc process. All welding shall be done by competent welders conforming to the American Standard Code for Pressure Piping SA B31-1, Section 6, Chapter 4, and Appendix A. At the request of the Owner's representative the Contractor shall furnish certification from an approved testing agency or National Certified Pipe Welding Bureau that the welders performing the work are qualified.

F. PVC Pipe: Install in strict conformance to applicable Codes and ordinances and according to manufacturer's published installation instruction. Solvent weld or fusion weld in accordance with published manufacturer's instructions. Use Borg-Warner BW Clear for 2" and smaller and BW Heavy Duty for over 2".

G. Valves connecting copper tubing to threaded pipe shall be threaded valves as specified elsewhere and shall be fitted with a bushing on the side which connects to copper tubing. Copper to copper valves may be bronze, solder joint type.

H. Adapters: Wrought copper male adapters shall be used wherever it is necessary to connect copper tubing to a valve or tee having threaded connections.

I. Dielectric Unions: Provide dielectric connectors between copper and dissimilar metals.

3.6 PIPING HANGERS AND SUPPORTS

A. General

1. Miscellaneous: Provide all supports, anchors, concrete pads, grouting, bedding, bracing, vibration isolation, and accessories required for pumps and other equipment.

2. Support all piping with appropriate manufactured devices as specified use no wire or makeshift device.

3. The engineer prior to installation shall approve all hanger material.

4. Size hanger rods, screws, bolts, nuts, etc., according to manufacturer's recommendations. Size hangers to fit around bare pipe, isolator, or insulated pipe shield as appropriate.

5. Use cadmium plated or galvanized hangers, attachments, rods, nuts, bolts and other accessories where exposed to weather. Hot dip galvanize all items which are not factory finished. Plating for hinged movements must be done at factory.

6. Hanger rods with C-clamp type structural attachment shall be equipped with retaining straps.

7. At each support on bare copper tubing or piping system, install an isolator; at each support point on insulated piping systems, install an insulated pipe shield.

8. Burning, welding, cutting, or drilling on any structural member may only be done if approved by the structural engineer.

9. No valve or piece of equipment shall be used to support the weight of any pipe.

10. Provide a hanger close to the point of change of direction of pipe run in either horizontal or vertical plane.

11. When hangers or supports do not come within one foot of a branch line fitting, install an additional hanger or support at the fitting.
B. Pipe Supports

1. Horizontal Lines
   a. Suspend all horizontal pipes individually and not in contact with the structure except as specified below. Support each branch line with at least one hanger.

C. Parallel pipes may be supported on trapeze type hangers. Size trapeze hangers to support weight of piping plus a surcharge of 300 pounds. For three or more pipes use a size suitable for the load in accordance with manufacturers published load ratings. No deflection to exceed 1/180 of a span. Anchor rods securely to building structure.

D. Lines Near Floor

1. Support all piping near the floor individually by means of adjustable steel pipe stanchions with welded end plates properly secured to the pipe and to the floor. Alternate: Lines also near walls may be suspended as specified above for horizontal lines, from appropriately sized and mounted angle brackets.

2. Hanger Spacing Schedule:

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>1&quot; dia. Or under</th>
<th>1½&quot; to 2&quot; dia.</th>
<th>2½&quot; dia. &amp; over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Pipe</td>
<td>8'-0&quot;</td>
<td>10'-0&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>Copper Tubing</td>
<td>6'-0&quot;</td>
<td>8'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>Support at 8' - 0&quot; intervals and on each side of and within 12&quot; of both sides of joint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rod Size:</td>
<td>3/8&quot;</td>
<td>½&quot;</td>
<td>5/8&quot;</td>
</tr>
<tr>
<td>Pipe Size</td>
<td>(1½&quot; - 2&quot;)</td>
<td>(2 ½&quot; - 5&quot;)</td>
<td>(6&quot; - 8&quot;)</td>
</tr>
</tbody>
</table>

3.7 SEISMIC RESTRAINTS

A. Seismic supports and bracing for all piping and equipment shall be furnished and installed in accordance with 2016 CBC. Standard support and anchorage methods and materials published by SMACNA and approved by State agencies may be used.

B. Seismic Restraints and Isolators:

1. All isolators specified shall be specified for seismic zone 3 provide seismic calculations with submittals.

2. All restraints and isolators shall comply with local codes and must meet Seismic Zone 3 requirements.

3. Contractor is responsible for full compliance.

3.8 PIPING PENETRATIONS

A. Where pipes penetrate members of the structure, install proper sleeves, packing, flashing, and collars as follows unless shown otherwise.

1. Penetrations of fire-rated partitions, walls, and plenum walls or floors shall be sealed per U.L. approved details.

2. At exposed face of wall, floor, or ceiling, fit penetrating pipe with a neat, rigid, securely attached collar or escutcheon. In unfinished areas use galvanized plate; in finished areas use chrome plated escutcheon.
3. Install isolators at all hangers and clamps supporting uninsulated piping and tubing and at all points that pipe comes in contact with structure or other pipes.

3.9 VALVE INSTALLATION

A. Valves and Strainers
1. All shutoff valves in chilled and heating hot water lines shall be ball valves, unless otherwise shown.
2. Provide valves and strainers of the same size as the pipe in which they are mounted unless specifically shown otherwise.
3. Furnish discs suitable for service intended.
4. All valves shall be properly packed and lubricated.
5. Unions shall be placed adjacent to each threaded or soldered valve.
6. Connect valves and strainers in copper piping systems with solder-to-threaded brass adapters.
7. Provide valves with trim proper to the service on which they are applied.
8. Locate above-grade valves:
   a. With stems above the horizontal plane of the pipe unless above ceiling.
   b. With valve handles below the horizontal for ease of access when above ceiling.
   c. Within six feet of floor where possible and reasonable.
   d. Out from under equipment.
   e. Readily accessible with adequate clearance around operating wheel or lever handle.
9. Provide shut-off valves at all inlet connections of coils, and equipment; on multiple coil banks, provide shut-off valve at the inlet of each coil. On water systems in sizes 2 ½” and larger, butterfly valves shall be used for shut-off service in lieu of ball valves. Provide gear driven operators for all valves 6” and larger.
10. Provide balance valves at all outlet connections of coils, and equipment in hydronic systems; multiple coil banks. Provide a balance valve at the outlet of each coil.
11. Fit each strainer with globe or ball type blow down valve sized to match blow down tapping in screen retainer; run discharge pipe to nearest floor drain or other appropriate discharge point as shown or directed.

B. Air Vents
1. At all locations indicated on the drawings, provide an automatic air vent or manual air vent and ½” ball valve(s). Connect to piping system at high points on main pipe risers, water coils and other indicated locations. Install in accessible locations. Do not install in concealed areas.

C. Instrumentation: Install all instrumentation items in a location where they are readily viewable and serviceable.

D. Flow Measuring Devices: Install flow-measuring devices in accordance with manufacturer’s recommendations. Provide required minimum distances upstream and downstream of the installed device. Notify Engineer prior to installation if these minimum requirements cannot be met in the location shown on the drawings for device installation.
3.10 PRESSURE TEST FOR PIPE SYSTEMS

A. Test all piping at completion of rough in, in accordance with the following schedule and show no loss in pressure or visible leaks after a minimum duration of 12 hours at the test pressure indicated. The contractor shall furnish testing equipment. Testing personnel shall be competent to conduct the tests, and demonstrate satisfactory completion of tests to the engineer.

1. Before covering, concealing, or using any piping system or parts thereof, test and prove tight; obtain certification of the inspector that this has been accomplished. Valves and connected equipment or any system component with a pressure rating less than the system test pressure shall not be subjected to the test. If systems are tested in sections, include connections to preceding tested sections in ensuing tests.

2. All systems specified to be tested using water as the test medium shall be first checked by pre-testing the test section or system with compressed air at five psig for a period of thirty (30) minutes. Correct any major leak disclosed by this pre-test before proceeding with the specified testing using water as the test medium.

3. After producing the specified test pressure, disconnect the pressurizing source; do not introduce further pressure for the duration of the test period. Should any pressure loss or detectable leak occur within test period, repair piping and retest. Repeat the procedure until the system is proved tight.

4. Open all air vents at high points to accelerate air removal.

<table>
<thead>
<tr>
<th>System Tested</th>
<th>Test Pressure PSIG</th>
<th>Test Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>All heating hot water</td>
<td>150</td>
<td>Water, let stand 12 hours</td>
</tr>
<tr>
<td>Refrigerant liquid piping</td>
<td>250</td>
<td>Nitrogen, let stand 12 hours</td>
</tr>
<tr>
<td>Refrigerant suction piping</td>
<td>150 and 28&quot; vacuum</td>
<td>Nitrogen, let stand 12 hours</td>
</tr>
</tbody>
</table>

3.11 OWNERS INSTRUCTION

A. Review the installation of all equipment and controls with the Owner after all systems are operating automatically. Instruct the Owner in the adjustment of all control and equipment devices. Allow a minimum of 4 hours for this instruction.

3.12 FILLING AND CLEANING OF PIPING SYSTEMS

A. Piping cleaning: after pipe installation and before installing valves or making final connections, flush or purge piping systems clean of foreign substances, using water to flush piping conducting liquids and compressed air to clear piping conducting gases, except as specified otherwise in other piping sections.

B. Clean each system as follows

1. Add cleaner to water in system in sufficient quantity to obtain recommended concentrations.

2. Circulate the cleaning solution through the system for 24 hours. During this cycle, chillers, boilers and other equipment shall not be in the loop with the new piping.

3. At the end of the circulation cycle, shut down any operating equipment and flush the system as rapidly as possible; continue flushing until the alkalinity of the solution in the system has reduced to that of the water supplied for flushing.
4. Drain system.
5. Clean all strainers and screens in system.
6. Before each system is put into operation, analyze the supply water and introduce treatment chemicals into the system in sufficient quantity to bring the concentration to the recommended starting dosage. The contractor performing the cleaning and chemical treatment shall provide a letter certifying the correct concentration is attained.

3.13 CHEMICAL TREATMENT OF WATER SYSTEM

A. Coordination: Examine the drawings and installation of each system to be treated; note extent, materials, etc. Coordinate location and installation of treatment system connections and apparatus with the installer of the systems being treated.

B. General
   1. Supply all material and labor requisite to timely execution of this work.
   2. The mechanical contractor shall provide cleaning of strainers and installation of chemical treatment equipment.
   3. After each system has been operated for a period of one week, test the chemical concentration. If the level has dropped below the initial concentration, add sufficient chemical to raise the concentration to required levels.
   4. Provide indoctrination and water management program as specified.

C. Mechanical contractor shall provide all necessary pumps, bypass piping and strainer to allow circulation during chemical treatment process.

D. Heating hot water system
   2. Treatment Feeders: Wingert, one-shot feeder, or equal, minimum five gallon capacity, designed to meet pressure requirements of the system.
   3. Treatment Chemicals: Nalco 2833, corrosion and scale inhibitor.

3.14 ADJUSTING AND FINISHING

A. Air Vents: After all air has been purged from hydronic systems, close all valves serving automatic air vents.

END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes:
   1. Provide all equipment, and accessories for the HVAC systems as specified herein; place in satisfactory operation.
   2. Noise and vibration isolation requirements as specified in Section 23 05 48- Noise and Vibration.
   3. Controls and Instrumentation as specified herein.

1.2 QUALITY ASSURANCE

A. Welding Qualifications: Welders shall be certified in accordance with American Welding Society "Standard Qualification Procedure".

PART 2 - PRODUCTS

2.1 BASE-MOUNTED HVAC CENTRIFUGAL PUMPS

A. Shall be Bell & Gossett, Paco, Taco, bronze fitted pumps furnished complete with motor and base as scheduled on the drawings...

B. See schedule on drawings for size, capacity and duty.

C. Pump volute shall have gauge and drain tappings and shall be of cast iron construction suitable for servicing the internal parts without disturbing the connecting piping or the pump motor.

D. Pump shall be rated for a minimum of 175 psi working pressure.

E. Impeller shall be bronze, enclosed, statically and dynamically balanced, and fitted to shaft with a key and locked in place. All fixed speed pumps shall have the impeller trimmed after installation to match the pump to the specified gpm.

F. Pump shall have mechanical shaft fitted with a bronze sleeve and the bearing frame assembly shall be fitted with re-greasable ball bearings for quiet operation.

G. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg. F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.

H. Base plate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully opened. A flexible type, center drop-out design coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor.
I. Motors shall be Nema Premium efficiency, Century Model E Plus III, Reliance XE, or equal, open drip proof for indoor installations and TEFC for outdoor installations, 1.15 service factor, single speed. Motors shall be able to overcome starting load inertia as well as accelerating the load to rated speed under both rated and at 10 percent reduced voltage conditions during starting without excessive heating. Motors connected with VFDs shall be rated for such.

J. Pump and motor shall be factory aligned and adjusted in the field by the contractor as needed.

K. Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

L. See schedule for power requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lubrication: Where equipment includes poorly accessible lubrication points, provide tubing extensions to readily accessible points and terminate with appropriate lubrication fitting.

B. Miscellaneous: Install belt and coupling guards and other miscellaneous items as required.

C. All pump bases shall be grouted.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Section 23 05 00, General Mechanical Requirements applies to this section.
B. Sections 23 05 29, 23 05 48, 23 05 53 and 23 07 19.

1.2 SUMMARY
A. Work Included
   1. Provide complete piping systems for conduction of heating hot water supply and return, chilled water supply and return, and other fluids for HVAC work including all other chemicals required for pipe flushing, cleaning, testing, etc., all as specified or shown on the drawings.
   B. Provide all valves, strainers, piping supports, seismic braces, piping penetration auxiliaries, protective coverings, piping insulation, and other piping appurtenances as shown or specified for HVAC work.
   C. Installation of sensing and control devices that mount on or insert into piping.

1.3 QUALITY ASSURANCE
A. All HVAC equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.
B. Standards: Comply with all applicable codes or standards governing process piping, system materials, application, and installation.
C. Welding Qualifications: Welders shall be certified in accordance with American Welding Society "Standard Qualification Procedure".

1.4 REFERENCES
A. Pipes and Tubes

B. Fittings
C. Joining Materials
   1. Solder Filler Metal: ASTM B 32, alloys to suit system requirements.
   2. Brazing Filler Metals: AWS A5.8, alloys to suit system requirements.

1.5 STRUCTURAL REQUIREMENTS
   A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer and approval from DSA.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS
   A. Copper/Soldered Joints
      1. Pipe: Type L, Type K or Type M hard drawn copper tubing per ASTM B-88, plain ends.
      3. Unions: Solder type, cast red bronze.
      4. Joining Materials/Methods
         a. Canfield, Silvabrite or equal lead-free solder with a non-corrosive water based flux.

2.2 REFRIGERANT SYSTEM COMPONENTS
   A. Refrigerant Piping (R, RL, RS): Type L, hard copper ACR tubing with silver soldered joints and wrought copper fittings. Do not reduce sizes due to long runs.
      1. Contractor shall have the option to use manufacturer's "Line Sets" for total lengths of lines of 50'-0" from ACCU to coil. Suction lines shall be insulated as hereinbefore specified.
      2. An inverted vapor line trap shall be installed in all systems when the condensing unit is below the furnace or fan coil. The top peak of the trap must be at least one inch higher then the top of the indoor coil.
      3. Install a liquid line solenoid on all systems when the refrigerant lines are installed underground, including all refrigerant lines installed in buried pipes and when the total equivalent line length exceeds 50 feet.
      4. Install a hard start capacitor and relay on all systems, except three-phase systems, when the refrigerant lines are installed underground, including all refrigerant lines installed in buried pipes and when the total equivalent line length exceeds 50 feet. If a factory installed soft start is included with the unit, this must removed prior to installation of the hard start kit.
      5. A suction accumulator must be installed on all systems when the refrigerant lines are installed underground and when the total equivalent line length exceeds 50 feet, including all refrigerant lines installed in buried pipes. The accumulator shall be sized to receive a minimum of 70% of the total system refrigerant charge. The additional refrigerant charge beyond the 15 feet of line included in the unit charge as noted in the nameplate data. Include the additional refrigerant charge due to the larger diameter liquid line.
6. Install a crankcase heater on all systems when the refrigerant lines are installed underground, including all refrigerant lines installed in buried pipes and when the total equivalent line length exceeds 50 feet.

7. Install a liquid-line filter drier on all systems when the refrigerant lines are installed underground, including all refrigerant lines installed in buried pipes and when the total equivalent line length exceeds 50 feet.

8. Install a 5 minute outdoor unit cycle protector on all units.

9. Install a liquid line sized per manufacturer’s instructions on all systems when the equivalent refrigerant line length exceeds 50 feet.

2.3 HANGERS AND SUPPORTS

A. Building Attachments: Powder-actuated-type, drive-pin attachments with pullout and shear capacities appropriate for supported loads and building materials, UL listing and FM approval for fire-protection systems. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Provide beam clamp retaining straps for all pipe supports where attached to steel beams.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pullout and shear capacities appropriate for supported loads and building materials.

C. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

D. B-Line, finish: Electro-Chromate or hot dipped galvanized.

   1. Individual: B3690, B3100 cleavis or B3110
      a. Use H-104 all thread rod.
      b. Use B3110 for pipe subject to movement.


   3. For insulated pipe - B3690 pipe hangers sized to allow pipe insulation to pass continuously through the hanger.
      a. Trapeze Supporting Rods: Diameter sufficient to support the load with a safety factor of 5.
      b. Isolators: 319 CT or Trisolator.

PART 3 - EXECUTION

3.1 INSTALLATION OF REFRIGERANT PIPING

A. Install Bare Metal Pipe Isolators: Stoneman “Trisolator”, Superstrut “Cust-aStrip”, Unistrut on all non-insulated refrigerant piping.

B. Install pipe supports on the outside of the insulation for all insulated refrigerant piping.

C. The buried portion of the refrigerant lines shall be buried in gravel filled trench. The refrigerant lines shall be installed in a 4” minimum schedule 40 PVC plastic pipe. The 4” pipe shall be sealed moisture tight to prevent moisture from entering the buried refrigerant lines.

   1. The buried portions of the refrigerant lines shall slope towards the indoor unit.
2. All the PVC joints shall be sealed with joint cement to prevent moisture leakage.
3. There should be a minimum of joints in the buried portion of the refrigerant lines. If the buried portion is less than 20 feet, there should not be any joints in the buried portion.
4. The refrigerant leak test shall be performed prior to final sealing of the PVC pipe.
5. The refrigerant suction line must be insulated through the buried portion as well as all other portions as previously specified.

3.2 PIPING HANGERS AND SUPPORTS

A. General
1. Miscellaneous: Provide all supports, anchors, concrete pads, grouting, bedding, bracing, vibration isolation, and accessories required for pumps and other equipment.
2. Support all piping with appropriate manufactured devices as specified use no wire or makeshift device.
3. The engineer prior to installation shall approve all hanger material.
4. Size hanger rods, screws, bolts, nuts, etc., according to manufacturer’s recommendations. Size hangers to fit around bare pipe, isolator, or insulated pipe shield as appropriate.
5. Use cadmium plated or galvanized hangers, attachments, rods, nuts, bolts and other accessories where exposed to weather. Hot dip galvanize all items which are not factory finished. Plating for hinged movements must be done at factory.
6. Hanger rods with C-clamp type structural attachment shall be equipped with retaining straps.
7. At each support on bare copper tubing or piping system, install an isolator; at each support point on insulated piping systems, install an insulated pipe shield.
8. Burning, welding, cutting, or drilling on any structural member may only be done if approved by the structural engineer.
9. No valve or piece of equipment shall be used to support the weight of any pipe.
10. Provide a hanger close to the point of change of direction of pipe run in either horizontal or vertical plane.
11. When hangers or supports do not come within one foot of a branch line fitting, install an additional hanger or support at the fitting.

B. Pipe Supports
1. Horizontal Lines
   a. Suspend all horizontal pipes individually and not in contact with the structure except as specified below. Support each branch line with at least one hanger.

C. Parallel pipes may be supported on trapeze type hangers. Size trapeze hangers to support weight of piping plus a surcharge of 300 pounds. For three or more pipes use a size suitable for the load in accordance with manufacturers published load ratings. No deflection to exceed 1/180 of a span. Anchor rods securely to building structure.
1. Hanger Spacing Schedule:

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>1&quot; dia. Or under</th>
<th>1¼&quot; to 2&quot; dia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper Tubing</td>
<td>6'-0&quot;</td>
<td>8'-0&quot;</td>
</tr>
<tr>
<td>Rod Size:</td>
<td>3/8&quot;</td>
<td>½&quot;</td>
</tr>
</tbody>
</table>

3.3 TESTING OF REFRIGERANT PIPING

A. Test all piping at completion of rough-in, in accordance with the following schedule and show no loss in pressure or visible leaks after a minimum duration of 12 hours at the test pressure indicated. The contractor shall furnish testing equipment. Testing personnel shall be competent to conduct the tests, and demonstrate satisfactory completion of tests to the engineer.

<table>
<thead>
<tr>
<th>System Tested</th>
<th>Test Pressure Psig</th>
<th>Test Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerant – Liquid</td>
<td>250</td>
<td>Nitrogen, let stand 12 hours</td>
</tr>
<tr>
<td>Refrigerant – Suction</td>
<td>150 and 28&quot; vacuum</td>
<td>Nitrogen, let stand 12 hours</td>
</tr>
</tbody>
</table>

B. Before covering, concealing, or using the refrigerant piping system or parts thereof, test and prove tight; obtain certification of the inspector that this has been accomplished.

C. Valves and connected equipment or any system component with a pressure rating less than the system test pressure shall not be subjected to the test.

D. If systems are tested in sections, include connections to preceding tested sections in ensuing tests.

E. After producing the specified test pressure, disconnect the pressurizing source; do not introduce further pressure for the duration of the test period. Should any pressure loss or detectable leak occur within test period, repair piping and retest. Repeat the procedure until the system is proved tight.

F. Test all piping as noted above, with no leaks or loss in pressure. Repair or replace defective piping until tests are accomplished successfully.

END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION

A. General

1. The design intent shall be to provide a totally automated water treatment system.
2. Provide all equipment, apparatus, material, and supervision necessary to fit and apply chemical treatments to the water systems prior to startup of the mechanical systems involved.
3. The mechanical systems involved include:
   a. Heating Hot Water System. (Closed System)

B. Work Described Elsewhere:

1. Mechanical equipment and piping systems - other Sections of Division 23.

1.2 QUALITY ASSURANCE

A. Qualifications of Supplier:

1. Work required under this Section shall be done by the Mechanical Contractor with all chemicals supplied by Nalco for hot water systems.
2. The water treatment chemical and service supplier shall be a recognized specialist, active in the field of industrial water treatment, whose major business is in the field of water treatment, and who shall have regional water analysis laboratories and service department with full time service personnel located within the trading area of the job site.
3. The indoctrination and water management program shall be conducted by a qualified full-time local representative.

B. Water Quality Analysis:

1. Water Treatment design shall be based on an independent city water analysis performed within the last three months.

C. Installation of Owner supplied electrical Pulsed Power water treatment equipment in compliance with:

1. OSHA recognized North American Testing Laboratory (NRTL) standards and bearing a “Registered Certification Mark” on the assembly with endorsements for USA and Canada affixed on the equipment. Certification marks identifying UL, CSA, and ETL are to be considered equivalent.
2. US Federal Communications Commission CFR 47(FCC) PART 18, 2006 for radiated emissions
3. US EPA registration as pesticide, device or active ingredient producing establishment

1.3 SUBMITTALS

A. Refer to Specification Section 25 05 00
B. Product Data: Include rated capacities; water pressure drops; shipping, operating and installed weights; and furnished products listed:
   1. Installation of Owner supplied Dolphin WaterCare™ Pulsed Power Water Treatment Equipment for four chillers.
   2. Installation of Owner supplied controllers, bleed valve, related equipment and devices
   3. Water treatment automation equipment

C. Shop Drawings: Detailed equipment assemblies indicating dimensions, weights, electrical loads, accessories, and location and size of field connection. Produce detailed diagrams for:
   1. Field power and control wiring for equipment TDS sensors and controllers.
   2. Field piping schematics for control loop
   3. Field piping schematics for blow down/bleed piping
   4. Process control diagrams for accessories and controllers

D. Raw Water Analysis: Submit a copy of the project site water analysis to document the water quality available at the project site. Raw water test analysis shall include at a minimum the analysis of the following compositions of the water:
   1. Calcium Hardness (as ppm CaCO3)
   2. Total Hardness (as ppm CaCO3)
   3. Total Alkalinity or m-Alkalinity (as ppm CaCO3)
   4. pH
   5. Silica (as SiO2)
   6. Specific Conductivity (µS/cm)
   7. Sulfate (as SO4)
   8. Chloride (as Cl-)
   9. Phosphate (as PO4)

E. Installation, Maintenance and Operation data for each piece of equipment, suitable for inclusion into a standard 3-ring binder shall be submitted in quantities specified in the General Conditions.

F. Material Safety Data Sheets: Water treatment provider shall submit MSDS for all products used which are covered under the OSHA MSDS Program.
   1. Control system and remote communications system, including interaction with or incorporation in the central plant distributed control system.
   2. All water treatment equipment to be used.
   3. Manufacturer's concurrence to the proposed treatment system and chemicals, pertaining to their equipment
   4. Recommendations and procedures for chemical cleaning and flushing of systems prior to placing them in service
   5. Description of water treatment program for each system based on the chemical water analysis. Include information on chemicals to be used, residuals to be maintained (ppm) and anticipated chemical usage and cost, for each system.
G. The contractor shall submit references (including facility, contact person and phone number) for similar facilities being serviced. This shall include separate listings for facility start-ups, accounts less than six months old, accounts six months to two years old, and accounts older than five years.

H. The contractor shall submit the name and resume of the water treatment representative that will service the account.

I. After award of the contract, the contractor shall submit operation, maintenance, and training manuals, which will contain information on all equipment, chemicals, the water treatment program for each system including chemical control parameters and guidelines, and the testing methods and procedures.

J. Shop Drawings: Submit shop drawings on complete system describing equipment, apparatus, material, and application of treatment. Include wiring diagrams for electrically operated apparatus or equipment.

K. The contractor shall submit the name and resume of the water treatment representative that will service the account.

L. After award of the contract, the contractor shall submit operation, maintenance, and training manuals, which will contain information on all equipment, chemicals, the water treatment program for each system including chemical control parameters and guidelines, and the testing methods and procedures.

M. Shop Drawings: Submit shop drawings on complete system describing equipment, apparatus, material, and application of treatment. Include wiring diagrams for electrically operated apparatus or equipment.

1.4 REFERENCES


B. CTI Code STD-149(00) Corrosion Testing Procedures, Corrosion Coupon Testing and Test Devices

C. OSHA Regulations Standards - 29CFR, PART 1900, Standard 1200, Toxic and Hazardous Substances (MSDS)


E. US Federal Communications Commission CFR 47(FCC) PART 18, 2006 for radiated emissions

F. US Environmental Protection Agency (EPA) FIFRA compliance as per 7 U.S.C. SS 136e and US EPA compliance as per 40CFR PART 167

1.5 QUALIFICATIONS:

A. Equipment Manufacturer:
   1. Shall be able to document a minimum of 10 years experience designing, manufacturing and supplying products for commercial and industrial water treatment and water chemistry control.
   2. Shall maintain engineering and field service capabilities to ensure proper operation of the product within the service period specified in subsequent sections.
   3. Shall be able to document the program equivalent to “Dolphin Oversight” project management for the first year of operations including:
      a. Assurance of manufacturer examination service reports
      b. Program for noting deviations reported
      c. Lines of responsibility for corrective actions to cure deviations
      d. Shall be registered with the US EPA registration as pesticide, device or active ingredient producing establishment.

1.6 WARRANTY:

A. Manufacturer’s standard form warranty of not less than one year from date of start-up covering replacement or repair of materials found to be defective in workmanship or quality.

1.7 EXTRA STOCK

A. Chemicals: Provide a supply of treatment chemicals sufficient for one year of operation or as specified in each section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE EQUIPMENT & MANUFACTURERS

A. The water treatment service company shall be ISO 9000 certified as a recognized specialist active in the field of industrial water treatment. The contractor shall have regional water analysis laboratories, development facilities, and a service department located within the trading area of the job site. The contractor shall provide the aforementioned certification and documentation.

B. Specific treatment system and chemicals must be approved by the equipment manufacturer supplying equipment requiring the water treatment.

C. Chemical Pot Feeders shall be:
   1. Acme
   2. Penn
   3. Wagner or equal

2.2 CHEMICALS

A. All chemicals used shall be environmentally safe and acceptable to the EPA, FDA, USDA, AHA.

B. All chemicals used shall be acceptable to the various equipment manufacturers.
C. All chemicals shall have statistically processing control charts which are automatically downloaded into an SPC data management program (SmartSystem Interface Program, SID).

D. Provide the following chemicals in the chemical feed system:
   1. Open Recirculation Systems: Chemical to keep impurities suspended in water and biological agent as required.

2.3 CLOSED RECIRCULATION SYSTEMS

A. Closed recirculation systems shall include the following:
   1. Space Heating Loop and Boilers

B. General: Installation of Owner provided equipment for a complete system including pot feeders for the chemical treatment of aforementioned systems.
   1. Provide compound suitable for makeup quality and makeup rate which will not cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids.
   2. Maintain inhibitor residual as determined by the water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.

C. System Protection:
   1. Protect various wetted and coupled materials of construction including ferrous and nonferrous metals.
   2. Maintain system essentially free of scale, corrosion and fouling.
   3. Corrosion rate of following metals shall not exceed the following mils per year penetration:
      a. Ferrous, 5.0 mpy
      b. Brass, 1.0 mpy
      c. Copper, 1.0 mpy
   4. Inhibitor shall be stable at equipment skin surface temperature and bulk water temperatures of not less than 250 degrees F and 125 degrees F, respectively.

PART 3 - EXECUTION

3.1 CHEMICAL TREATMENT OF WATER SYSTEM

A. Coordination: Examine the drawings and installation of each system to be treated; note extent, materials, etc. Coordinate location and installation of treatment system connections and apparatus with the installer of the systems being treated.

B. General
   1. Supply all material and labor requisite to timely execution of this work.
   2. The mechanical contractor shall provide cleaning of strainers and installation of chemical treatment equipment.
3. After each system has been operated for a period of one week, test the chemical concentration. If the level has dropped below the initial concentration, add sufficient chemical to raise the concentration to required levels.

4. Provide indoctrination and water management program as specified.

5. Mechanical contractor shall provide all necessary pumps, bypass piping and strainer to allow circulation during chemical treatment process.

C. Heating Hot Water System
   2. Treatment Feeders: Wingert, one-shot feeder, or equal, minimum five-gallon capacity, designed to meet pressure requirements of the system.
   3. Treatment Chemicals:Nalco 2833, corrosion and scale inhibitor.

3.2 PREPARATION

A. Coordination: Examine the drawings and installation of each system to be treated; note extent, materials, etc. Coordinate location and installation of treatment system connections and apparatus with the installer of the systems being treated.

B. Mechanical contractor shall provide all necessary bypass piping to allow circulation during chemical treatment process.

C. Mechanical contractor shall provide all required point of connections to piping to allow connection to temporary pumps provided as mentioned above for flushing.

D. Other:
   1. Supply all material and labor requisite to timely execution of this work.
   2. Cleaning of strainers and installation of chemical treatment equipment shall be provided by the mechanical contractor.
   3. Insure that all piping systems affected have been flushed and cleaned as specified in HVAC Piping specification.
   4. Mechanical Contractor is to remain on site at all times during the chemical treatment process.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Size and install the control loop piping to conductivity and optional sensors and/or corrosion coupon racks in the size PVC to match fittings provided. Install field provided full port ball valves for isolation of sensors and racks for routine maintenance. Control loop sensors shall not be installed directly in the piping mains.

D. Control loop shall be piped from the pressure side of the recirculation pump to the suction side of the pump, so that the control loop senses the highest temperature of the fluid system. Pipe from side of main to minimize dirt and air introduction to the control loop sensors and piping.
E. Blow down/bleed line should not be attached to the control loop. Install the blow down/bleed line on the pressure side of the recirculation pump, preferably from the bottom of the pipe to relieve the system of accumulated solids, dirt, and debris.

F. Confirm applicable electrical requirements in Division 16 Sections for connecting electrical equipment. Power and control and interlock wiring materials and labor provided by Division 16.

3.4 START-UP OF CLOSED LOOP HOT WATER SYSTEM

A. System cleaning and flushing: Provide chemicals for and coordinate with applicable trades for cleaning and flushing all piping systems and all related equipment. Systems shall be flushed until total alkalinity of rinse water is equal to makeup water. For galvanized equipment, pretreatment must consist of non-alkaline, non-acid liquid passivator and cleaner.

B. Conduct performance tests to verify capacity and performance of the chemical feed equipment and control systems, prior to start-up and acceptance of any mechanical system receiving water treatment. Provide documentation.

C. Provide chemicals, dosage estimates, and supervision necessary to place all systems requiring chemical treatment in service. Monitor systems and make feed adjustments to bring all parameters into correct operating range. Adjust control systems for automatic operation.

D. Performance Test Report: Submit written report of the test results to the Architect.

3.5 INDOCTRINATION

A. Training: Provide four hours of training to the Owners operating personnel, instructing them clearly and fully on the installation, care, maintenance, testing, and operation of the water treatment systems.

B. Other: Provide the Owners personnel with:
   1. Two copies of each appropriate data sheet on apparatus, equipment, and chemicals.
   2. An appropriate supply of record charts and log sheets for their use.

END OF SECTION
SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General: Refer to Section 23 05 00, Mechanical - General.

B. Work Included: Provide all ductwork and ductwork accessories, auxiliaries, and adjuncts for all and systems as specified or shown.

C. Work Described Elsewhere: HVAC piping, equipment, and controls are specified in other HVAC Sections.

PART 2 - PRODUCTS

2.1 DUCT WORK

A. Requirements

1. Shop Fabricated Ductwork

a. Fabricate ductwork as required by classification as described below or gauges, and of configuration and sizes shown on the Drawings. Note that duct sizes shown are net inside; where ducts are lined, fabricate larger than shown to accommodate lining with shown dimensions net inside lining.

b. Fabricate ducts and fittings as shown on drawings, or if not detailed, fabricate in accordance with SMACNA.

c. Fabricate ducts with adequate cross-bracing or reinforcing to prevent drumming; should drumming subsequently occur, provide additional reinforcement as necessary to overcome same.

d. Construct ducts to provide smooth passage for the conducted air, laying edges exposed to the airstream in the direction of air flow.

e. Fabricate elbows or other fittings for changing direction of duct with a centerline radius equal to 1.5 times the duct width unless shown otherwise or necessitated by space restrictions. Where square or short radius turns are shown or required, fit with air turning vanes.

f. Fabricate diverging transitions with side slopes of 1:6; fabricate converging transitions with side slopes of 1:2. Greater slopes may be used only where space restriction prohibits specified slopes.

2. Factory fabricated ductwork construction shall conform to applicable requirements stipulated above for shop fabricated ductwork.

B. Galvanized Steel Ductwork (GSD)

1. Rectangular Cross Section

a. Shop fabricated of prime grade lock seam for quality galvanized steel sheet in accordance with requirements stipulated above and fitted with auxiliaries and accessories as specified below and shown on the drawings.

2. Low Pressure Ductwork, up to 2" static pressure and 2,500 fpm:
3. Rectangular Duct: GSD gauge per SMACNA or C.M.C whichever is more stringent.

4. Round Duct: As manufactured by United McGill Corp or equal. Uni-Rib, UNIRIB DUCT machine formed, spiral lock seam construction spot welded and bonded seams with an intermediate standing rib for rigidity. Slip joint construction couplings with a minimum of 2" insertion length. GSD gauge per SMACNA or C.M.C whichever is more stringent.

5. Fittings: (except elbows) machine formed using SMACNA RL-1 seams with seal class B.

6. Plenums: Fabricate cross-brake panels and stiffen with galvanized steel angle iron members. Provide duct access doors as specified below and as shown on drawings.

7. Elbows: fittings shall have a wall thickness not less than that specified for longitudinal straight ducts as shown in Table 3-2 and 3-3, SMACNA HVAC Duct Construction Standards, Metal and Flexible, 4" - 8" two piece, die stamped with fully welded longitudinal seam; 9" - 30", segmented standing seam construction; 31" - 36", segmented construction with joint spot welded and bonded. Each segmented elbow shall have the number of segments as indicated by Table 3-1 SMACNA HVAC Duct Construction Standards, Metal and Flexible for above 1500 fpm.

C. Medium Pressure Duct, from above 2" to 6" static pressure and to 4000 fpm:

1. All ductwork shall be constructed per SMACNA guidelines or C.M.C whichever is more stringent for medium pressure ductwork.

2. Flat Oval Duct:
   a. As manufactured by United McGill Corp or equal. Uni-Seal flat oval duct and fittings, spiral lock seam or fully welded longitudinal seam, as needed, construction, and FORC reinforcing connectors.

<table>
<thead>
<tr>
<th>Major Axis</th>
<th>up to 24&quot;</th>
<th>25&quot;- 36&quot;</th>
<th>37&quot;- 48&quot;</th>
<th>49&quot;- 60&quot;</th>
<th>61&quot; - 70&quot;</th>
<th>71&quot; &amp; Up</th>
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<tbody>
<tr>
<td>GSD Gage:</td>
<td>24</td>
<td>22</td>
<td>22</td>
<td>20</td>
<td>20</td>
<td>18</td>
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<tr>
<td>Fittings</td>
<td>20</td>
<td>20</td>
<td>18</td>
<td>18</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

b. Fittings: (except elbows) machined formed using SMACNA RL-1 seams with seal class A.

3. All ductwork shall be constructed per SMACNA guidelines or C.M.C whichever is more stringent for medium pressure ductwork.

4. Round Duct:
   a. As manufactured by United McGill Corp or equal. Uni-Seal heavy gauge round duct and fittings machine formed, spiral lock seam or fully welded, as needed, construction for rigidity.

b. Fittings: (except elbows) machined formed using SMACNA RL-1 seams with seal class A.

5. Unless otherwise specified, standing seam joint shall be used wherever possible on all fittings. All standing seam joints shall be sealed with a UL-Classified zero flame spread and zero smoke developed cement specially formulated for bonding metal-to-metal joints. In lieu of standing seam construction, joints may be solid welded or spot welded and bonded. All welded joints shall be coated with a protective paint, inside and out, to prevent damage to the galvanized surface. Spot-welded fittings shall have all joints sealed with a UL-Classified zero flame spread and zero smoke developed cement specially formulated for bonding metal-to-metal joints.
6. Elbows: fittings shall have a wall thickness not less than that specified for longitudinal straight ducts as shown in Table 3-2 and 3-3, SMACNA HVAC Duct Construction Standards, Metal and Flexible, 4" - 8" two piece, die stamped with fully welded longitudinal seam; 9" - 30", segmented standing seam construction; 31" - 36", segmented construction with joint spot welded and bonded. Each segmented elbow shall have the number of segments as indicated by Table 3-1 SMACNA HVAC Duct Construction Standards, Metal and Flexible for above 1500 fps.

7. Divided-flow fittings shall be constructed with a radiused entrance to all branch taps and with no excess material projecting from the body into the branch tap entrance.

8. Liner for all fittings shall be as specified above.

D. Conical Fittings:

1. Low pressure:
   a. All conical fittings shall be constructed with a minimum 2" flare around entire perimeter and a minimum 1:2 slope unless noted otherwise.

2. Medium pressure:
   a. All conical fittings shall be constructed with a minimum inlet equal to 1.5 times the outlet (1.5 x D) and a length equal to 0.7 times the outlet (0.7 x D) where D equals the duct diameter.
   b. All conical fittings shall be constructed per SMACNA HVAC Construction Standards Metal And Flexible, figure 2-6

E. 45 degree entry fittings:

1. All 45 degree entry fittings shall be constructed per SMACNA HVAC Construction Standards Metal And Flexible, figure 2-6.

2.2 DUCTWORK ACCESS

A. Duct Access Doors:

1. Access panels - Rectangular ducts
   a. Size to provide easy access, but not less than 18" wide.
   b. Ventfabrics "Ventlok" insulated, hinged and latched type or equal

2. Access panels - Round ducts
   a. Size to provide easy access, but not less than 18" wide.
   b. Ductmate-Metu round insulated access door or equal

3. Plenum doors: Fabricate of 16 gauge galvanized sheet metal, cross broken, stiffened with angle iron, and set airtight. On insulated plenums make doors double wall, filled with 3" thick 6 lb. density glass fiber insulation. Trim: Ventlok, Young, #370 or #264 hinges, #260 latch, #390 half round gasket.

2.3 DUCTWORK ADJUNCTS

A. Intake/Exhaust Screens: Provide ½" mesh 18 gauge galvanized iron bird screens at all exterior openings in mechanical system except where provided by others.

B. Combustion Air Openings: Provide corrosion resistant ¼" screen mesh at all combustion air openings except where ducts terminate in attics.
C. Insulation: As specified in Section 23 07 00, Insulation.

D. Test Fittings: Ventlok #699.

E. Duct Penetrations:
   1. Where ducts penetrate fire separations in the building, provide fire dampers or smoke/fire dampers as specified, shown and required by code.
   2. Where ducts penetrate roof or exterior walls, provide 24 gauge galvanized sheet metal flashing and counterflashing; solder all joints and make watertight, including under all air handlers, around all duct work penetrations, and exhaust fans.

F. Sealants
   1. Design Polymeric DP1020, Ductmate PROseal high velocity duct sealant, Childers CP-146/CP-148, Fosters 32-19/32-17, or equal, UL 723, ASTM E-84
   2. Low Shrinkage, flexible, and mildew resistant conforming to NFPA 90A and 90B

G. Tapes and Adhesives:
   1. Pressureless Tapes: Hardcast, 4" wide Type DT 5400 mineral impregnated woven fiber tape with manufacturer's FTA-20 activator/adhesive (indoors) and RTA-50 activator/adhesive (outdoors), applied with brush or roller in accordance with manufacturer's directions.

H. Transverse Duct Connections:
   1. Traverse Joints: Ductmate or WDCI proprietary duct connection systems will be accepted. Ductwork constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements. TDC/TDF/T-24 shall be constructed as a SMACNA T-24 flange.
   2. The Ductmate companion angle with an integral polymer mastic seal shall be securely fastened to the duct walls using self-drilling screws, rivets or spot welding. Fastener spacing shall be as recommended by the manufacturer for the size or duct and the pressure class. The raw duct ends shall be properly seated in the integral mastic seal. A continuous strip of closed cell gasket tape, size 1/4" x 3/4", shall be installed between the mating flanges of the companion angles at each transverse joint, and the joint shall be made up using 3/8" diameter x 1" long plated bolts and nuts. Drive-on or snap-on cleats shall be used at spacings as recommended by the manufacturer.
   3. The Ductmate system shall not be used for applications with duct gauges heavier than 16 gauge or lighter than 26 gauge.
   4. Longitudinal Seams: Pittsburgh Lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with a mastic sealant. Snaplock is not acceptable.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Galvanized Steel Ductwork (GSD): Except where specified or shown otherwise, use (GSD) conforming to requirements (Part 2), or cross section configuration shown, in all locations (indoor/outdoor, above/below grade, concealed/exposed).

B. Flexible Fibrous Glass Duct (FFG): Use (FFG) only where specifically called for on the drawings, as connection between terminal boxes and air outlets.
C. Kitchen hood and equipment exhaust duct shall be in accordance with CMC Chapter 5.

3.2 DUCTWORK

A. Pressure-Velocity Classification:
   1. All supply ductwork upstream of terminal units (medium pressure):
      a. All ductwork shall be constructed per SMACNA static pressure class of positive +6” and a velocity of 4000 FPM.
      b. Seal all joints and seams on all ducts and plenums per SMACNA seal class A. Pressure sensitive tapes are not allowed.
   2. All supply ductwork downstream of terminal units (low pressure):
      a. All ductwork shall be constructed per SMACNA static pressure class of positive +2” and a velocity of 2500 FPM.
      b. Seal all joints and seams on all ducts and plenums per SMACNA seal class B. Pressure sensitive tapes are not allowed.
   3. All supply ductwork on constant volume systems (low pressure):
      a. All ductwork shall be constructed per SMACNA static pressure class of positive +2” and a velocity of 2500 FPM.
      b. Seal all joints and seams on all ducts and plenums per SMACNA seal class B. Pressure sensitive tapes are not allowed.
   4. All return ductwork (low velocity):
      a. All ductwork shall be constructed per SMACNA static pressure class of negative -2” and a velocity of 2500 FPM.
      b. Seal all joints and seams on all ducts and plenums per SMACNA seal class B. Pressure sensitive tapes are not allowed.
   5. All general exhaust ductwork [excluding kitchen and process systems] (low pressure):
      a. All ductwork shall be constructed per SMACNA static pressure class of negative -2” and a velocity of 2500 FPM.
      b. Seal all joints and seams on all ducts and plenums per SMACNA seal class B. Pressure sensitive tapes are not allowed.

B. Ductwork Downstream of Air Conditioning Units:
   1. Penetrations:
      a. Description: All penetrations of walls separating shall have a minimum clearance of 1/2-inch and a maximum clearance of 3/4 inch.
      b. Materials: A minimum 1.5 lbs/cu.ft. fiberglass insulations shall be used and a nonhardening caulking compound.
      c. Installation: The opening around the penetration shall be filled loosely with the fiberglass insulation. The opening is then to be sealed airtight with the nonhardening caulking compound. Pipes, ducts, etc., shall be supported on either side of the wall with supports to roof structure.

C. Broken places in galvanized coating made in forming shall be completely covered with galvanized paint.

D. All ductwork shall comply with the C.M.C and the local jurisdiction’s addendum.
E. Ducts shall be reinforced in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005 (low pressure and medium pressure, where shown on drawings). Duct shall be diagonally creased on all four sides. Seams shall be double crimped, bent and elbows shall be made with the throat radius of all bends 12" diameters of the width of the duct wherever possible and in no case shall the throat radius be less than one diameter of the branch duct. Where space does not permit the above radius or where square elbows are indicated on the drawings, they shall be equipped with turning vanes of an approved type for low velocity ducts. Medium velocity ducts shall not use turning vanes and shall not use square elbows unless shown otherwise. Use Ductmate closure systems for all round and rectangular ducts.

F. Transition pieces in the ducts shall have the sides sloped approximately one to five and no abrupt changes or offsets of any kind in the duct system will be permitted. Round to round take-offs shall be made with 45° wye fittings.

G. Ductwork Auxiliaries
   1. Flexible Connectors
      a. Install duct sections being fitted with a flexible connector with a 3" minimum gap between the ends being bridged by the flexible connector. Provide a generous fold in connector to allow for movement; staple and seal closure.
      b. Provide 26-gauge galvanized steel weather shield on top and sides of flexible duct connectors for outdoor installations. Install weather shield at same time as flexible connectors; unprotected flexible connections will be replaced with new connectors at contractor's expense if the weather shields are installed at a subsequent time.

H. Access and Inspection Panels and Doors
   1. Install panels and doors so that frames do not protrude into air stream. Mount frame against outside of lined ducts; provide 13" flanged stub for access panels on other ducts.
   2. Provide inspection panel at each splitter damper.
   3. Provide access panel at each fire damper or smoke/fire damper and elsewhere in the ductwork as required. Label as specified in Part 2 above.
   4. Plenum doors: Refer to Part 2 above.
   5. Wall and ceiling access panels: Furnish as required for access to ducts, damper operators, duct mounted access panels, etc.; coordinate size and location to obtain good access.

I. Duct sizes shown on lined duct shall be clear inside insulation.

J. Paint the inside of ductwork visible through grilles and registers dull black.

K. Furnish and install 1-1/2 x 1-1/2 x 3/16" closure angles around all exposed ducts through walls and ceilings. (Both sides)

L. Furnish and install 2 x 2 x 3/16" closure angle dams around all ducts through floors. Weld corners, seal with silicone non-hardening sealant and anchor to floor.

M. Access doors shall be provided in ductwork for easy access to each fire damper and smoke/fire damper.
3.3 FIELD QUALITY CONTROL

A. General
   1. Perform testing and provide demonstrations as specified in other HVAC Sections.
   2. Comply with requirements of Part 3, 23 05 00.

B. Duct Cleaning
   1. Clean all ductwork in the shop prior to shipping. All ductwork shall be transported to the
      site in covered vans to eliminate contamination or shall be sealed prior to shipment and
      shall be protected from contamination at the site.
   2. After fabrication, and during and after installation, seal sections of open ductwork with
      plastic sheeting to prevent the intrusion of dirt and debris.
   3. After installation is complete, but before balancing and final connections are made, and
      with construction filters in place, blow clean all ductwork with the system fans operating at
      full air volume.
   4. All return air ductwork shall be kept sealed until all construction is complete. If the air
      conditioning system is used during construction, the return air ductwork system shall not
      be used. Other means of outlets shall be used, such as leaving doors or windows open.

C. Ductwork Testing:
   1. All medium pressure ductwork (upstream of terminal units) is required to be field tested by
      the installing contractor for leakage per SMACNA’s "HVAC Air Duct Leakage Test
      Manual".
   2. Partial disassembly and sealing of the system may be necessary for compliance with test
      requirements.
   3. Allowable leakage shall be no greater than 1% of the design operating air volume for the
      entire system.
   4. Equipment for conducting leakage tests shall be a leakage test kit as manufactured by
      United McGill Corporation or an approved equal.
   5. Leakage for non duct components (fire dampers, smoke dampers, control dampers, etc.)
      is an integral part of overall system leakage, and these components shall be included in
      the duct leakage tests.
   6. Contractor shall provide the engineer with a report on the leakage test(s) and a copy of
      certified calibration data for leakage test apparatus.

D. Demonstrations: Before enclosing ductwork operate each fire damper and smoke/fire damper
   in the presence of the Owners representative to show that each damper is functional.

E. Inspections: Evidence of poor fabrication or installation, as disclosed by job site inspections,
   will be cause for rejection; replacement or repair of defective work shall be done at no
   additional cost to the Owner.

3.4 ADJUSTING AND FINISHING

A. General: Comply with requirements of Part 3, 23 05 00. Adjust fan speeds as necessary.

END OF SECTION
SECTION 23 31 16
NONMETAL DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General: Refer to Section 23 05 00.

B. Work Included: Provide all ductwork and ductwork accessories, auxiliaries and adjuncts for all systems as specified or shown.

C. Work Described Elsewhere: HVAC piping, equipment, and controls are specified in other HVAC Sections.

PART 2 - PRODUCTS

2.1 DUCT WORK

A. Factory-made air ducts shall be approved for the use intended or shall conform to the requirements of C.M.C. Standard No. 6-1.
   1. Each portion of a factory-made air duct system shall be identified by the manufacturer with a label or other suitable identification indicating compliance with C.M.C. Standard No. 6-1 and its class designation. These ducts shall be listed and shall be installed in accordance with the terms of their listing.
   2. All factory-made air ducts must be Approved Class 0 or Class 1.

B. Flexible Ducts: Comply with SMACNA's "Duct Construction Standards, Metal and Flexible. Owens-Corning Fiberglass Valuflex or equal, insulated, wire helix type, 6 inch W.C. min. Product shall qualify as Class I Air Duct per UL181. Inner liner shall be black where visible through registers. All flexible ductwork must have a FHC not exceeding 25/50.

C. Flexible Ductwork - Circular Cross Section:
   1. Thermaflex, Anaco Flex Systems, Cal-Flex Model #2PPJ or equal insulated flexible glass fiber duct factory fabricated as a Class 1 air duct, constructed of 2-layers of polyester film 100% bonded together, encapsulating the galvanized steel wire. Insulated with fiberglass insulation and jacketed with a reinforced vapor barrier jacket listed and labeled as a Class 1 Air Duct. Tested in accordance with U.L. Standard 181. Meets all requirements of NFP 90-A & 90-B, UMC Standard 6.1, Appendix A. Inner liner shall be black where visible through registers. All flexible ductwork must have a FHC not exceeding 25/50.
   2. R-Value shall be 8.0 or greater in accordance with ADC Flexible Duct Performance and Installation Standards.
   3. Joint sealant: Fiberglass Type II (glass fabric) Duct Tape with a UL 181 B-M rating and conduit strap, as detailed on drawings.

PART 3 - EXECUTION

3.1 APPLICATIONS
A. Flexible Fibrous Glass Duct (FFG): Use (FFG) only where specifically called for on the drawings, as connection between terminal boxes and air outlets.

B. All ductwork shall comply with the C.M.C and the local jurisdiction's addendum.

C. Flexible Fibrous Glass Ducts (FFG) - install as follows:
   1. In a single piece not exceeding 5 feet in length.
   2. With each section carrying a UL Class I label.
   3. With no sharp bends. Do not bend size 4" through 12" diameter in excess of 180° in a 6 ft. length; do not bend sizes over 12" diameter in excess of 90° in a 6 ft. length.
   4. Listed flexible duct: Install flexible duct as per manufacturers instructions. With all metal-to-metal connections secured with Panduit PLT-8H clamps or stainless steel cinch clamp, apply duct sealant between the end of the duct and the collar in a 2-inch band and clamp as described above. Allow at least 48 hours before pressure testing.
   5. Supported at 4 ft. centers with 24 gauge, 12" galvanized saddles.

D. Flexible Fibrous Glass Ducts (FFG) – shall not be used to replace rigid elbows or fittings per the CMC.

3.2 FIELD QUALITY CONTROL

A. General
   1. Perform testing and provide demonstrations as specified in other HVAC Sections.
   2. Comply with requirements of Part 3, Section 23 05 00.

B. Duct Penetrations:
   1. Where ducts penetrate fire separations in the building, provide fire dampers or smoke/fire dampers as specified, shown and required by code.

C. Demonstrations: Before enclosing ductwork operate each fire damper and smoke/fire damper in the presence of the Owners representative to show that each damper is functional.

D. Inspections: Evidence of poor fabrication or installation, as disclosed by job site inspections, will be cause for rejection; replacement or repair of defective work shall be done at no additional cost to the Owner.

END OF SECTION
SECTION 23 33 13
DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Section 23 05 00, General Mechanical Requirements applies to this section.

1.2 QUALITY ASSURANCE

A. All HVAC equipment shall comply with California Code of Regulations, Title-24, Part 6, latest edition.

B. Comply with UL 1/81 and UL 181A for ducts and closures.

PART 2 - PRODUCTS

2.1 DAMPERS

A. All dampers for us in low temperature air below 50° F duct shall have non-conducting composite damper shafts with shaft bearings and air seats.

B. Manual Dampers:

1. Round Ductwork 16" and smaller (low pressure):
   a. Butterfly type, volume dampers.
   b. Provide locking mechanism shall be provided on either the quadrants or end bearings. Ventlock or equal. Damper blade shall be a minimum of 22 gauge, but not less than two gauges more than the duct gauge.
   c. All duct penetrations shall be gasketed to prevent air leakage.
   d. Provide stand-offs as required for specified insulation thickness (see section 23 07 13.
   e. Continuous 3/8" min rod shall be provided.
   f. In locations where ducts are exposed use Ventlok #688 damper regulator for low pressure applications.

2. Round Ductwork 18" and larger (low pressure):
   a. Manual Dampers: Opposed blade type, 6" maximum blade width, Vent Products model 5303 or equal.

3. Rectangular Ductwork 12" high and smaller (low pressure):
   a. Rectangular volume dampers shall be Air Balance #111 or equal.

4. Rectangular Ductwork larger than 12" high (low pressure):
   a. Rectangular volume dampers shall be Air Balance #AC-2 or equal.

5. Stainless Steel Ductwork:
   a. All materials used for dampers shall be stainless steel.
C. Control Dampers:
   1. Ruskin CD-50, or equal, and shall be low leakage damper, with published leakage data certified under the AMCA certified ratings program showing leakage through a 48" x 48" damper at 4 in. w.g. pressure difference to be less than 6.2 cfm per sq. ft. Same published leakage data shall also include leakage information for all available damper sizes at pressure differences from 1 in. w.g. through 12 in. w.g.
   2. Low leakage dampers shall meet the following minimum construction standards: Frames shall be 5" x 1" x .125" minimum 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame.
   3. Each corner shall be reinforced with two die formed internal braces and machine staked for maximum rigidity.
   4. Blades shall be airfoil type extruded aluminum (maximum 6" depth) with integral structural reinforcing tube running full length of each blade.
   5. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket which enables air pressure from either direction to assist in blade-to-blade seal off. Blade seals shall be locked in extruded blade slots without use of cement, yet shall be easily replaceable in field.
   6. Bearings shall be non-corrosive two piece molded synthetic. Axles shall be square or hexagonal, round are not acceptable, to provide positive locking connection to blades and linkage.
   7. Linkage shall be concealed in frame.
   8. Damper manufacturer's literature shall include performance data developed from testing in accordance with AMCA Standard 500 in an AMCA APPROVED LABORATORY showing pressure drop for all sizes of dampers required at all anticipated air flow rates.
   9. Controls/Actuators will be furnished and mounted by others.

PART 3 - EXECUTION

3.1 DAMPERS
   A. Install duct accessories according to applicable portions of details of construction as shown in SMACNA standards.
   B. Install volume-control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.
   C. Ductwork shall comply with Chapter 6 C.M.C.
   D. Where ducts penetrate fire separations in the building, provide fire dampers or smoke/fire dampers as specified, shown and required by code.
E. Balancing Dampers

1. Provide balancing dampers (same as volume dampers specified in this section) where shown on drawings and any other locations required to achieve proper system air balance. In general, balancing dampers are required at all zone supply air ducts from supply air plenums, equipment, and in ducts to supply and return air grilles. All dampers shall be placed as shown. Minimum of seven duct diameters prior to the diffuser or register.

2. Damper operators shall be installed in either to side or bottom of ductwork.

END OF SECTION
SECTION 23 33 23

TURNING VANES

PART 1 - GENERAL

1.1 – SEE 23 05 00 PART 1

PART 2 - PRODUCTS

2.1 AIR TURNING VANES AND DEVICES

A. Ordinary type installed in elbows: Type, size, etc., as shown on drawings (see Duct Symbol Legend), fiberglass turning vanes are not acceptable. Install multiple turning vane sections with vanes 36” long or less in large elbows. Use turning vanes specifically rated for medium velocity when duct velocity exceeds 2,500 fpm.

1. Installed at duct branches or take-offs where shown: Ward Industries VNN, VNA, Airsan Accoustiturn, or equal.

2. Installed downstream of VAV boxes in supply ductwork and in all return ductwork.

PART 3 - EXECUTION

3.1 AIR TURNING VANES AND DEVICES

A. Provide at all square elbows and elsewhere as shown and scheduled on drawings. Do not use double thickness duct turns on turns less than 12” wide. Where height of double thickness duct turns exceeds 36”, provide 1” H 1” H 16 gauge channel brace at mid-height, secure to duct at both ends. Acoustical duct turns: Where height exceeds 36” provide 16 gauge channel brace at mid-height secured to duct at both ends. Fiberglass turning vanes will not be acceptable.

END OF SECTION
SECTION 23 33 43
FLEXIBLE CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Section 23 05 00, General Mechanical Requirements applies to this section

1.2 QUALITY ASSURANCE
A. All HVAC equipment shall comply with California Code of Regulations, Title 24, Part 6, latest edition.
B. Comply with UL 181 and UL 181A for ducts and closures.

PART 2 - PRODUCTS

2.1 EQUIPMENT
A. Flexible Connectors: Ventloks, flexible fabric, Duralon Flexible fabric with Metalfab connectors at connections to fans and air handling equipment.
   1. Comply with UL 181, Class 1.
   2. Minimum fabric weight 26 oz./sq. yd. ± 2 oz., thickness 0.019".
   3. Ventfabrics Inc. Vention, or equal, for exterior applications, resistant to sunlight, ozone and weather.
   4. Ventfabrics Inc. Ventglass, or equal, for interior applications.
   5. Complies with Underwriters Laboratories Standard # 214 for fire retardancy, and is accepted by the National Fire Protection Association for vibration isolation connectors in duct systems as covered by Paragraph 2-1.2.3 NFPA Bulletin #90A.
   6. Bonding Agent, Ventfabrics # 655 Adhesive or equal.

PART 3 - EXECUTION

3.1 DUCTWORK AUXILIARIES
A. Flexible Connectors
   1. Install duct sections being fitted with a flexible connector with a 3" minimum gap between the ends being bridged by the flexible connector. Provide a generous fold in connector to allow for movement; staple and seal closure.
   2. Provide 26-gauge galvanized steel weather shield on top and sides of flexible duct connectors for outdoor installations. Install weather shield at same time as flexible connectors; unprotected flexible connections will be replaced with new connectors at contractor's expense if the weather shields are installed at a subsequent time.
3. Ductwork shall be supported separately from the fan within 3 feet of the flexible connection.

END OF SECTION
SECTION 23 33 53

DUCT LINER

PART 1 - GENERAL

1.1 – SEE 23 05 00

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Miscellaneous equipment not specified herein shall be furnished as scheduled on the drawings.

B. C.C.R. - Title 24 Energy Standards, Requirements: All insulation values shall meet current requirements of the C.C.R. Energy Standards.

2.2 DUCT WORK

A. Rectangular Duct, Flexible Blanket Liner: Flexible blanket made from strong, glass fibers bonded with a dark impregnated thermosetting resin as manufactured by Johns Manville or equal.

1. Air stream surface shall be protected with a smooth surface coating for minimum resistance to airflow, Permacote or equal, UL 723 compliant.

2. Flame spread not over 25, Smoke Developed not over 50.

3. The duct liner shall be suitable for direct application and service as a thermal/acoustical liner for hot or cold round ductwork at air velocities up to 6,000 fpm.

   a. 1” thickness

      1) Liner shall have a minimum R-value of 4.2 and Conductance of 0.25 at 75oF in accordance with ASTM C518

      2) Noise: Liner shall have a minimum NRC of 0.70 when tested in accordance with ASTM C423-90 and ASTM E795

   b. 1 ½” thickness

      1) Liner shall have a minimum R-value of 6.3 and Conductance of 0.16 at 75oF in accordance with ASTM C518

      2) Noise: Liner shall have a minimum NRC of 0.90 when tested in accordance with ASTM C423-90 and ASTM E795

   c. 2” thickness

      1) Liner shall have a minimum R-value of 8.0 and Conductance of 0.13 at 75oF in accordance with ASTM C518

      2) Noise: Liner shall have a minimum NRC of 1.00 when tested in accordance with ASTM C423-90 and ASTM E795

   d. The duct liner shall be suitable for direct application and service as a thermal/acoustical liner for hot or cold rectangular ductwork and plenums at air velocities up to 6,000 fpm.

B. Round Duct, Spiracoustic, and Spiracoustic Plus, Coated Liner as manufactured by Johns Manville or equal.
1. Air stream surface shall be protected with a smooth surface coating for minimum resistance to airflow, Permacote or equal, UL 723 compliant.

2. Flame spread not over 25, Smoke Developed not over 50.

3. The duct liner shall be suitable for direct application and service as a thermal/acoustical liner for hot or cold round ductwork at air velocities up to 6,000 fpm.

4. 1” Thickness
   a. Liner shall have a minimum R-value of 4.3 and Conductance of 0.23 at 75 degree F in accordance with ASTM C518.
   b. Duct diameters from 8” – 20”, Spiracoustic Preformed Liner Board, Noise: Liner shall have a minimum NRC of 0.70 when tested in accordance with ASTM C 423 or equal.
   c. Duct diameters from 18” – 30”, Spiracoustic Plus SD Round Liner Board. Noise: Liner shall have a minimum NRC of 0.75 when tested in accordance with ASTM C 423 or equal.
      1) Duct diameters from 32” or greater diameter, Spiracoustic Plus LD Round Liner Board. Noise: Liner shall have a minimum NRC of 0.75 when tested in accordance with ASTM C 423 or equal.

5. 1 ½” thickness
   a. Liner shall have a minimum R-value of 6.5 and Conductance of 0.23 at 75o F in accordance with ASTM C518.
   b. Noise: Liner shall have a minimum NRC of 0.90 when tested in accordance with ASTM C 423.
      1) Duct diameters from 9” – 22”, Spiracoustic Round Liner Board, or equal:
      2) Duct diameters from 22” – 38”, Spiracoustic Plus SD Round Liner Board:
      3) Duct diameters from 40” or greater diameter, Spiracoustic Plus LD Round Liner Board:

6. 2” Thickness
   a. Liner shall have a minimum R-value of 8.7 and Conductance of 0.23 at 75o F in accordance with ASTM C518.
   b. Noise: Liner shall have a minimum NRC of 1.0 when tested in accordance with ASTM C 423.
      1) Duct diameters from 10” – 28”, Spiracoustic Round Liner Board, or equal:
      2) Duct diameters from 34” – 62”, Spiracoustic Plus SD Round Liner Board:
      3) Duct diameters from 54” or greater diameter, Spiracoustic Plus LD Round Liner Board:

PART 3 - EXECUTION

3.1 DUCT LINER

A. Install volume-control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.
B. Duct Liner

1. Applications
   b. Rectangular Ductwork on Standard Temperature Systems Exposed to the Weather: Flexible Blanket/Coated Liner, 1 1/2" thickness.
   c. Round Ductwork on Standard Temperature Systems Exposed to the Weather: Flexible Blanket/Coated Liner, 1 1/2" thickness.

2. Install duct liner in all plenums, exposed ducts and ducts for a distance of 10' on each side of all fans, where specified here and at other locations indicated on drawings.

3. On rectangular duct secure duct and plenum liner with cement stic-klips at 12" o.c. both ways to duct with Mircale adhesive, then cement the lining in place with 50% covering of Fosters #81-99 Safetee Duct-Fas adhesive. Apply a brush coat of adhesive to edges of insulation where abutted together inside ductwork. Do not leave any raw edges of liner uncoated.

4. On round spiral duct install in accordance with the current Johns Manville Spiracoustic Round Liner System Installation Guide. Apply a brush coat of adhesive to edges of insulation where abutted together inside ductwork. Do not leave any raw edges of liner uncoated.

5. Duct sizes shown on lined duct shall be clear inside insulation.

END OF SECTION
SECTION 23 34 00 ESSENCE

HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with standard mounting hardware and variable speed control to provide cooling and destratification.

B. Summary of Work
   1. Installation of the fan, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Factory installation services are available through Big Ass Fans. Consult the appropriate installation scope of work for information on the available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements.

1.2 RELATED SECTIONS

B. 23 00 00 Heating, Ventilating, and Air Conditioning (HVAC)

C. 26 00 00 Electrical

1.3 REFERENCES

A. Technischer Überwachungsverein (TUV)

B. National Fire Protection Association (NFPA)

C. Underwriters Laboratory (UL)

D. Canadian Standards Association (CSA)

E. National Electric Code (NEC)

F. International Organization for Standardization (ISO)

1.4 SUBMITTALS

A. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods

B. Part 2 Product Data: Specification sheets on the ceiling-mounted fan, specifying electrical and installation requirements, features and benefits, and controller information

C. Revit Files: Files provided for architectural design

D. Installation Guide: The manufacturer shall furnish a copy of all operating and maintenance instructions for the fan. All information is subject to change without notice.
1.5 QUALITY ASSURANCE

A. Certifications
   1. The fan assembly, as a system, shall be TUV-certified and built pursuant to the guidelines set forth by UL standard 507 and CSA standard 22.2 No. 113.
   2. The fan shall be compliant with NFPA 13—Standard for the Installation of Sprinkler Systems, NFPA 72—National Fire Alarm and Signaling Code, and NFPA 70-2011—NEC.
   3. Controllers shall comply with NEC and UL standards and shall be labeled where required by code.

B. Manufacturer Qualifications
   1. The fan and any accessories shall be supplied by Big Ass Fans that has a minimum of ten (10) years of product experience.
   2. ISO 9001-certified
   3. The manufacturer shall not be listed on the Air Movement and Control Association International Inc. (AMCA) Certified Ratings Program (CRP) Non-Licensed Products report in the previous 36 months.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver product in original, undamaged packaging with identification labels intact. The fan shall be new, free from defects, and factory tested.

B. The fan and its components shall be stored in a safe, dry location until installation.

1.7 WARRANTY

A. The Warranty Period for surfaces with enhanced finishes (painted, anodized, etc.) on Essence shall be limited to one year. The manufacturer shall replace any products or components defective in material or workmanship for the customer free of charge (including transportation charges within the USA, FOB Lexington, KY), pursuant to the complete terms and conditions of the Big Ass Fans Non-Prorated Warranty in accordance to the following schedule:

<table>
<thead>
<tr>
<th>Item</th>
<th>Period of Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hub and airfoils</td>
<td>Lifetime (Parts)†</td>
</tr>
<tr>
<td>Motor, drive, and controller</td>
<td>10 years††</td>
</tr>
<tr>
<td>Labor</td>
<td>1 year††</td>
</tr>
<tr>
<td>Enhanced finishes†††</td>
<td>1 year†††</td>
</tr>
</tbody>
</table>

† "Lifetime" means a period ending seven (7) years after Big Ass Fans discontinues manufacturing the product, as such period is defined by Big Ass Fans, but in no event shall this period be less than 10 years from the date that the Warranty Period commences, as defined above.

†† The 10-Year Warranty Period and 1-Year Labor apply to non-residential installations only, and requires purchased installation by a factory-approved, Big Ass Fans certified installer and the submission of installation documentation by such installer. A 5-Year Warranty Period will apply for proper installations by any other state qualified or licensed electrical contractor. The Warranty is void in its entirety if the product is installed by personnel other than a state qualified or licensed contractor.
PART 2  PRODUCT

2.1 MANUFACTURER

A. Delta T Corporation, dba Big Ass Fans, PO Box 11307, Lexington, Kentucky 40575.
   Phone (877) 244-3267. Fax (859) 233-0139. Website: www.bigassfans.com.

2.2 HIGH VOLUME, LOW SPEED FANS – BIG ASS FANS ESSENCE

A. Complete Unit

   1. Regulatory Requirements: The entire fan assembly shall be TUV-certified and built
   pursuant to the construction guidelines set forth by UL standard 507 and CSA standard
   22.2. No. 113.

   2. Sustainability Characteristics: The fan shall be designed to move an effective amount of
   air for cooling and destratification of conditioned commercial applications over an
   extended life. The fan components shall be designed specifically for high volume, low
   speed fans to ensure lower operational noise. Sound levels from the fan operating at
   maximum speed measured in a laboratory setting shall not exceed 40 dBA. Actual
   results of sound measurements in the field may vary due to sound reflective surfaces and
   environmental conditions.

   3. Good workmanship shall be evident in all aspects of construction. Field balancing of the
   airfoils shall not be necessary.

B. Controls

   1. The fan controller shall be incorporated into the fan assembly and housed in an
   enclosure independent of the motor to prevent overheating or electrical interference.
   The fan controller shall be factory programmed to minimize starting and braking
   torques and shall be equipped with a simple diagnostic program and an LED light to
   identify and relay faults in the system.

C. Airfoil System

   1. The fan shall be equipped with eight (8) high volume, low speed airfoils of precision
   extruded, anodized aluminum alloy. Each airfoil shall be of the high-performance Mini-
   Ellipto design. The airfoils shall be connected to the hub and interlocked with eight (8)
   stainless steel retainers and two (2) sets of stainless steel bolts and lock washers per
   airfoil.

   2. The fan shall be equipped with eight (8) upswept winglets designed to redirect
   outward airflow downward, thereby enhancing efficiency. The winglets shall be
   molded of high strength polymer and shall be attached at the tip of each airfoil with a
   stainless steel screw. The standard color of the winglets shall be silver or black.

   3. As an option, the fan shall be equipped with eight (8) plug-style airfoil tips, molded of
   high strength polymer, in place of the eight (8) upswept winglets. The airfoil tips shall
   be attached at the tip of each airfoil with a stainless steel screw. The standard color of
   the airfoil tips shall be black.
D. Motor

1. The fan motor shall be a permanent magnet brushless motor rated for continuous operation at maximum speed with the capability of modulating the fan speed from 0–100% without the use of a gearbox or other mechanical means of control. The motor shall operate from any voltage ranging from 100–120 VAC or 200–240 VAC, single phase, and 50/60Hz, without requiring adapters or customer selection. The motor shall be a non-ventilated, heat sink design with the capability of continuous operation in -4°F to 131°F (-20°C to 55°C) ambient condition. The standard color of the motor unit shall be white with silver trim or silver with black trim.

2. The motor shall be rated at one of the following:
   a. 8-ft fan average power @ max speed = 475 Watts
   b. 10-ft fan average power @ max speed = 425 Watts
   c. 12-ft fan average power @ max speed = 350 Watts
   d. 14-ft fan average power @ max speed = 300 Watts

E. Mounting System

1. The fan mounting system shall be designed for quick and secure installation from a variety of structural supports. All components in the mounting system shall be of formed metal design using lowcarbon steel no less than 3/16” (0.5 cm) thick and containing no critical welds. The mounting system shall be powder coated for appearance and resistance to corrosion. All mounting bolts shall be metric stainless steel or equivalent. No mounting hardware substitutions, including cast aluminum, are acceptable.

2. The fan extension tube shall be a round, extruded aluminum tube. The extension tube shall include a chrome plate with forward and reverse controls and a fan status indicator light that is visible from the floor.

F. Hub

1. The fan hub shall be constructed of zinc plated steel for high strength and durability. The hub shall be precision machined to achieve a well-balanced and solid rotating assembly.

G. Safety Cable

1. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be Ø3/16” (0.5 cm) diameter and fabricated out of 7 x 19 stranded galvanized steel, pre-loaded and tested to 3,200 lbf (13,345 N).

2. Field construction of safety cables is not permitted.

H. Wall Control

1. Wired (standard). The fan shall be equipped with a low-voltage wired remote wall control providing control of all fan functions. The wall control shall be capable of mounting to a standard electrical box or directly to a wall surface. The wall control shall include a rotary-style dial for controlling the fan’s power and speed and an LED light to identify and relay faults in the system. Communication with the fan drive and controller shall be by a standard, commercially available CAT5 (or higher) Ethernet cable that is field installed and provided by the installer.
2. Wireless (optional). As an option, the fan shall be equipped with an optional radio frequency (RF) remote wall control in place of the wired wall control. The wall control shall provide control of all fan functions. The wall control shall be capable of mounting to a standard electrical box with an owner-supplied wall plate and shall include a capacitive touch display for controlling the fan’s power and speed. Communication with the fan drive and controller shall be wireless.

I. Fire Control Panel Integration
   1. Includes a 10–30 VDC pilot relay for seamless fire control panel integration. The pilot relay can be wired Normally Open or Normally Closed in the field.

J. Guy Wires
   1. Guy wires shall be included for installations with extension tubes 4 ft (1.2 m) or longer to limit the potential for lateral movement.

PART 3  EXECUTION

3.1  PREPARATION

   A. Fan location shall have a typical bar joist or existing I-beam structure from which to mount the fan. Additional mounting options may be available.

   B. Mounting structure shall be able to support weight and operational torque of fan. Consult structural engineer if necessary.

   C. Fan location shall be free from obstacles such as lights, cables, or other building components.

   D. Check fan location for proper electrical requirements. Consult Installation Guide for appropriate circuit requirements.

   E. Each fan requires dedicated branch circuit protection.

3.2  INSTALLATION

   A. The fan shall be installed by a factory-certified installer according to the manufacturer’s Installation Guide, which includes acceptable structural dimensions and proper sizing and placement of angle irons for bar joist applications. Big Ass Fans recommends consulting a structural engineer for installation methods outside the manufacturer’s recommendation and a certification, in the form of a stamped print or letter, submitted prior to installation.

   B. Minimum Distances

      1. Airfoils shall be at least 10 ft (3 m) above the floor.

      2. Installation area shall be free of obstructions such as lights, cables, sprinklers, or other building structures with the airfoils at least 2 ft (0.61 m) clear of all obstructions.

      3. The structure the fan is attached to shall be capable of supporting a torque load of up to 40 ft·lb (54 N·m) of torque.

   C. The fan shall not be located where it shall be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems or radiant heaters. Additional details are in the Big Ass Fans 3.2 Installation Manual.
D. The fan is suitable for use in wet locations when installed on a GFCI protected branch circuit.

E. In buildings equipped with sprinklers, including ESFR sprinklers, fan installation shall comply with all of the following:
   1. The maximum fan diameter shall be 24 ft (7.3 m).
   2. The HVLS fan shall be centered approximately between four adjacent sprinklers.
   3. The vertical clearance from the HVLS fan to the sprinkler deflector shall be a minimum of 3 ft (0.9 m).
   4. All HVLS fans shall be interlocked to shut down immediately upon receiving a水流 signal from the alarm system in accordance with the requirements of NFPA 72—National Fire Alarm and Signaling Code.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with mounting hardware, a remote control, and SenseME™ Technology as manufactured by Haiku® Home.

B. Summary of Work

1. Installation of the fan, wireless network, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Installation services are available through Haiku Home. Consult the appropriate installation scope of work for information on the available installation options, overview of customer and installer responsibilities, and details on installation site requirements.

1.2 RELATED SECTIONS

B. 23 00 00 Heating, Ventilating, and Air Conditioning (HVAC)

C. 26 00 00 Electrical

1.3 REFERENCES

A. Canadian Standards Association (CSA)

B. International Organization for Standardization (ISO)

C. National Electric Code (NEC)

D. National Fire Protection Association (NFPA)

E. Norma Oficial Mexicana (NOM)

F. Underwriters Laboratory (UL)

1.4 SUBMITTALS

A. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods

B. Part 2 Product Data: Specification sheets on the ceiling-mounted fan, specifying electrical and installation requirements, features and benefits, and controller information

C. Revit Files: Files provided for architectural design

D. Part 2 Product Documentation: The manufacturer shall furnish a copy of all installation, operation, and maintenance instructions for the fan.
1.5 QUALITY ASSURANCE

A. Certifications

1. Safety
   a. The fan assembly, as a system, shall be Intertek/ETL-certified and built pursuant to the following standards.
      1) Canada
      2) United States
      b. The fan motor shall be Intertek/ETL-certified and built pursuant to the following standards.
         1) Canada
            a) CSA C22.2 No. 100. Standard for Safety for Motors and Generators.
            b) CSA C22.2 No. 77. Standard for Safety for Motors with Inherent Overheating Protection.
         c. United States

2. Sustainability Certification
   a. Forest Stewardship Council (FSC) certification
   b. ENERGY STAR® certification – ENERGY STAR Most Efficient 2018

B. Manufacturer Qualifications
   1. The fan and any accessories shall be supplied by Haiku Home that has a minimum of ten (10) years of product experience.
   2. ISO 9001-certified

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver product in original, undamaged packaging with identification labels intact. The fan shall be new, free from defects, and factory tested.

B. The fan and its components must be stored in a safe, dry location until installation.

1.7 WARRANTY

A. The manufacturer shall replace any products or components defective in material or workmanship, free of charge to the customer (including transportation charges within the USA, F.O.B. Lexington, KY), pursuant to the complete terms and conditions of the Haiku Home Non-Prorated Warranty in accordance to the following schedule:

**Industrial and Commercial Installations**

<table>
<thead>
<tr>
<th>Item</th>
<th>Period of Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>2 years</td>
</tr>
<tr>
<td>All other components</td>
<td>1 year</td>
</tr>
</tbody>
</table>

Labor to repair the defect will be provided free of charge at the Haiku Home service center.
for defects arising during the Warranty Period.

**Residential Installations**

<table>
<thead>
<tr>
<th>Item</th>
<th>Period of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage Motor</td>
<td>Lifetime of motor</td>
</tr>
<tr>
<td>All other components</td>
<td>1 year</td>
</tr>
</tbody>
</table>

Labor to repair the defect will be provided free of charge at the Haiku Home service center for defects arising during the Warranty Period.

**PART 2  PRODUCT**

2.1 **MANUFACTURER**

A. Haiku Home, PO Box 11307, Lexington, Kentucky 40575. Phone (877) 244-3267. Fax (859) 233-0139. Website: www.haikuhome.com.

2.2 **HAIKU® INDOOR**

A. Complete Unit

1. Regulatory Requirements: The fan assembly, as a system, shall be Intertek/ETL-certified and built pursuant to relevant safety standards as described above.

2. Sustainability Characteristics: The fan shall possess the ENERGY STAR Most Efficient 2018 designation. The fan assembly, as a system, shall be built pursuant to environmental and sustainability standards of the Forest Stewardship Council.

3. Quality: The fan shall display good workmanship in all aspects of its construction. Field balancing of the airfoils shall not be necessary.

4. Colors: Airfoil colors may be selected by the architect or owner as described in 2.2.C, "Airfoils."

5. Optional Accessories

   a. An LED light may be selected at the time of order.

   b. Universal Mount fans: A 0–10 V module may be selected at the time of order. The module shall enable the fan to be integrated with a home or building automation system or a 3rd party 0–10 V dimmer using an industry-standard protocol.

B. Mounting System

1. Low Profile Mount

   a. The low profile mount shall be suitable for flat ceilings as low as 8 ft (2.4 m) tall.

   b. The fan shall be equipped with a mounting plate, rubber bumpers, mounting brackets, a compact, low-profile motor hub assembly, and mounting hardware.

   c. The fan shall be available with a diameter of 52" (1.3 m) or 60" (1.5 m).

2. Standard Mount

   a. The standard mount shall be suitable for flat ceilings with heights ranging from 8.5–12 ft (2.6–3.7 m).

   b. The fan shall be equipped with a rubber bushing, mounting bracket, wiring cover, wiring cover trim, standard motor hub assembly, and mounting hardware.

   c. The fan shall be available with a diameter of 52" (1.3 m) or 60" (1.5 m).

3. Universal Mount

   a. The universal mount shall be suitable for flat or sloped ceilings with heights ranging from 8.5–18 ft (2.6–5.5 m).
b. The fan shall be equipped with a mounting bracket, canopy, mounting ball and wedge, extension tubes, wiring cover, motor hub, and mounting hardware.

c. A 7-inch (178-mm), 20-inch (508-mm), and 32-inch (813-mm) extension tube shall be included with 52-inch (1.3-m) and 60-inch (1.5-m) fans. A 20-inch (508-mm) and 32-inch (813-mm) extension tube shall be included with 84-inch (2.1-m) fans.

d. The fan shall be available with a diameter of 52" (1.3 m), 60" (1.5 m), or 84" (2.1 m).

C. Airfoils

1. The fan shall be equipped with three airfoils spanning a total diameter of 52" (1.3 m), 60" (1.5 m), or 84" (2.1 m), as specified by the architect or owner.

2. Airfoils shall be made of bamboo or aircraft-grade aluminum.
   a. Bamboo: Airfoils shall be available in Caramel (light brown) or Cocoa (dark brown) as specified by the architect or owner.
   b. Aluminum: Airfoils shall be available in Black, White, Polished Aluminum, Brushed Copper, Brushed Aluminum, Satin Nickel, or Oil-Rubbed Bronze.
   c. Airfoils shall be suitable for indoor spaces only.

D. Motor

1. The fan shall have an electronically commutated motor (ECM) rated for 100–240 VAC, single-phase.

2. The motor shall draw 1.41–52 watts depending on the speed at which the fan is operated and if a light is installed.

3. The fan shall be designed for continuous operation in ambient temperatures of 32–104°F (0–40°C), and
   a. humidity range of 20–90% (non-condensing).

4. The fan's motor unit and motor unit trim shall be available in the following finishes, as specified by the architect or owner.
   a. White, black, Satin Nickel, or Oil-Rubbed Bronze

E. Safety Cable

1. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 1.5 mm in diameter and fabricated of aircraft steel.

2. Field construction of safety cables is not permitted.

F. SenseME™ Technology

1. The fan shall be equipped with SenseME Technology for smart automation, and shall be able to wirelessly connect to local Ethernet networks or host a network. The fan's Wi-Fi capability shall permit over-the-air firmware updates.

2. SenseME Technology control features shall be managed by users via the Haiku mobile app. The Haiku mobile app shall be supported by Android™ and iOS® mobile devices.

3. Haiku Mobile App Control Modes
   a. Smart Mode. Alternates between seasonal settings—Smarter Heating and Smarter Cooling—to maintain comfort and maximize energy savings.
      1) Smarter Cooling. The user sets their ideal temperature, and the fan
automatically adjusts to find the most comfortable fan speed.

2) Smarter Heating. Automatically recirculates heat by increasing in speed when the user exits the room. When the user reenters the room, the fan slows.

3) Smart Thermostat. Automatically signals the fan to switch from Smarter Cooling to Smarter Heating when a connected smart thermostat switches to Cooling or Heating Mode.

b. Scheduling. Sets precise schedules for fan control modes.

c. Whoosh\textsuperscript{\textregistered} Mode. Silently varies fan speed to mimic cooling natural breezes.

d. Sleep Mode. Responds to changing conditions to provide customized comfort all night long.

e. Rooms. Enables users to group multiple fans in the same space for synchronized operation. Users shall be able to use the Haiku Home app to automate fan and light functions or adjust settings manually.

f. Manual Speed Control. Speed settings range from 0 (Off) to 7 (High).

g. Manual Light Control. The optional LED light has adjustable brightness and On and Off settings, as well as the ability to be controlled by the motion sensor and scheduling features. For fans with an LED light, see 2.2.H, "LED Light."

4. Haiku Account. Allows for integrated controls between fans and smart thermostats located on the same Wi-Fi network.

5. Sensors

a. Motion sensor. The fan and light turn off or on to the last enabled speed or brightness when a person leaves or enters the room.

b. Temperature and humidity sensor. The fan monitors room temperature and humidity in order to automatically adjust fan speed to reach the user's optimum thermal comfort level.

6. Display and sound

a. Changes to fan settings shall be confirmed with auditory feedback (a beep) and/or visual indication of the active setting.

b. The fan mode indicators shall be located on the bottom of the fan and shall be visible from the floor. Indicators shall automatically turn off approximately five seconds after a setting is activated.

c. Users shall have the ability to turn off the indicators and auditory feedback.

G. Remote Control

1. The fan shall be equipped with a compact IR remote control that allows intuitive operation of the fan in the following modes:

a. Speeds 0 (Off) through 7 (High).

b. Sleep Mode: Pressing the Sleep button on the remote shall activate the user's Haiku Home app Sleep settings or Wake Up settings.

c. Timer Mode: In Timer Mode, the fan runs at a set speed until the programmed time period ends.

d. Whoosh Mode: Silently varies fan speed to mimic cooling natural breezes.

2. The remote shall control both the fan and light. Light brightness shall be increased or decreased by pressing the Up or Down Light button on the remote, and the light shall be turned on or off by pressing the Light On/Off button.

3. Each operating mode shall be indicated by a pattern on the fan mode indicators,
which shall be located on the bottom of the fan and shall be visible from the floor. All indicators shall automatically turn off approximately five seconds after the last control button is pressed.

4. The remote shall be 1.2" wide x 3.4" tall x 0.2" thick (30 mm wide x 86 mm tall x 5 mm thick), and shall operate on a CR 2025 3 V lithium battery (included).

H. LED Light (Optional)
1. The fan shall be equipped with an LED light, as specified by the architect or owner.
2. The light kit shall include an LED light module, a diffused clear lens and a smoky lens, a lens trim, and mounting screws.
3. The diffused clear lens shall be installed for maximum light emission. The smoky lens shall be installed for softer light emission.

I. 0–10 V Module (Optional, Universal Mount fans)
1. The fan shall be equipped with a 0–10 V module, as specified by the architect or owner.
2. The module shall be compatible with Universal Mount fans.
3. The module shall be installed in the fan's mounting bracket.
4. The module shall provide independent control of fan speed and light intensity and shall support daisy chaining for one or up to 10 fans.
5. The module shall be compatible with any 0–10 V sinking/sourcing dimmer and with most home or building automation systems.

PART 3 EXECUTION

3.1 PREPARATION

A. The fan location must have an appropriate ceiling-mounted outlet box marked, "Acceptable for Fan Support." If there is not an appropriate outlet box already installed at the location, one must be installed on a ceiling joist or beam and be properly wired. Additional mounting options may be available. Consult the installation guide for additional details.

B. The fan location must be free from obstacles such as lights, cables, or other building components.

C. Check the fan location for proper electrical requirements. Consult the installation guide for appropriate circuit requirements.

3.2 INSTALLATION

A. Install the fan according to the manufacturer’s installation guide, which includes acceptable mounting methods.

B. Required Distances
1. For 60-inch (1.5-m) and 52-inch (1.3-m) fans, the airfoils must be at least 7 ft (2.1 m) above the floor.
2. For 84-inch (2.1-m) fans, the airfoils must be at least 8 ft (2.4 m) above the floor.
3. The airfoils must have at least 2 ft (0.6 m) clearance from all obstructions.
4. The fan must be within a 30 ft (9.1 m) radius of where the mobile digital device will
be used for control. (Line-of-sight obstructions may create a smaller maximum range.)

5. The fan shall not be located where it will be subjected to rain or continuous wind gusts, or in close proximity to the outputs of HVAC systems or radiant heaters. Consult the installation guide for additional details.

C. Install and set up the Haiku mobile app according to the manufacturer's instructions.

END OF SECTION
SECTION 23 74 33

PACKAGED ROOFTOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Provide all equipment and accessories for the packaged rooftop gas/electric air conditioning units as specified herein.
   2. Controls and Instrumentation as specified herein.

B. Starters.

C. Electrical power connections.

1.2 SCOPE

A. Installation of packaged, gas/electric, rooftop air conditioning units. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.3 RELATED DOCUMENTS

A. This Section includes rooftop heating and cooling units.

B. Related Sections include the following:
   1. Division 1
   2. Division 7 Section "Manufactured Roof Specialties" for type and style of roof curbs and equipment supports.
   3. Division 15 Section "Mechanical Vibration Controls and Seismic Restraints" for manufactured isolation bases.
   4. Division 15 Section "Control Systems Equipment" for temperature-control devices, and control wiring and control devices connected to energy recovery units.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, components, and location and size of each field connection.

C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

D. Maintenance Data: Maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.
1.5 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings" and Title 24 California Codes.

C. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
   1. The rooftop unit(s) shall be certified in accordance with UL Standard 1995 and ANSI Standard Z21.47
   2. The rooftop unit(s) shall be safety certified by an accredited testing laboratory and the nameplate shall carry the label of the certification agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver rooftop units as factory-assembled units with protective crating and covering as recommended by the manufacturer.

B. Coordinate delivery of units in sufficient time to allow movement into building.

C. Handle rooftop units to comply with manufacturers written rigging and installation instructions for unloading and moving to final location.

1.7 COORDINATION

A. Coordinate installation of roof curbs, roof plenums, equipment supports, and roof penetrations with roof construction. Roof specialties are specified in Division 7 Sections.

1.8 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.
   1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of startup.
   2. Warranty Period, Heat Exchangers: Manufacturers non-prorated full parts replacement not less than 15 years after date of startup.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Filters: One set of 4" filters for each unit to be installed prior to air balance.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Carrier or equal.

2.2 ROOFTOP UNITS

A. Description: Factory assembled and tested; designed for roof or slab installation; and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigerant and temperature controls, gas heater, filters, and dampers.

B. Construction
   1. Unit shall be completely factory assembled, piped and wired and shipped in one section.
   2. Unit shall be specifically designed for outdoor roof top application with a fully weatherproof cabinet.
   3. Cabinet shall be constructed entirely of G90 galvanized steel with the exterior constructed of 18 gauge or heavier material.
   4. All openings through the base pan of the unit shall have upturned flanges of at least ½ inch in height around the opening through the base.
   5. Paint finish shall be capable of withstanding at least 2000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
   6. The unit roof shall be sloped or cross broken to assure drainage.
   7. Access to compressor(s), controls, filters, blower, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with a quarter turn latch.
   8. Unit specific color coded wiring diagrams shall match the unit color coded wiring and will be provided in both point-to-point and ladder form.
   9. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.
   10. Access doors shall have stainless steel hinges and full perimeter gasketing.
   11. Air side service access doors shall have rain brake overhangs.
   12. All access doors will have an internal metal liner to protect the door insulation.
   13. The interior air side of the cabinet shall be entirely insulated on all exterior panels with 1 inch thick, 1 1/2 lb. density fiberglass insulation.
   14. Unit shall have decals and tags to indicate unit lifting and rigging, service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit, located in a metal pocket in the control access section.
   15. Unit shall have a 316 stainless steel, double sloping drain pan.

C. Supply Fans
   1. The fan(s) shall be belt drive single width single inlet airfoil centrifugal, plenum fan. Blower(s) shall be entirely self contained on a slide deck for service and removal from cabinet. Adjustable V-belt drive shall be provided with a minimum 140% of the nameplate
brake horsepower when the adjustable pulley is at the minimum RPM. Fan(s) and motor(s) shall be dynamically balanced.

D. Outside Air System
1. Shall be a fully modulating, sensible controlled economizer with multistage integrated economizer and compressor operation for maximum benefit. The economizer shall consist of a motor operated outdoor air damper and return air damper assembly constructed of extruded aluminum, hollow core, air foil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 25 CFM of leakage per sq. ft. of damper area when subjected to 2 in. w.g. air pressure differential across the damper. Damper motor shall be spring return to ensure closing of outdoor air damper during periods of unit shut down or power failure. Where indicated on controls drawings furnish actuator to accept a 0 to 10 volt D.C. signal by controls contractor. Economizer damper assembly shall be entirely self contained on a slide deck for service and removal from cabinet.

2. Exhaust/Relief Fans
3. The fan(s) shall be belt drive forward curve or plenum style. Adjustable V-belt drive shall be provided with a minimum 140% of the nameplate brake horsepower when the adjustable pulley is at the minimum RPM. Fan(s) and motor(s) shall be dynamically balanced. Provide modulating exhaust flow rate to maintain room pressure requirements. Modulate flow using an airfoil opposed blade damper using a null pressure control, as indicated on controls drawings and plans.

E. Motors
1. Motors shall be Energy + Plus efficiency as manufactured by Baldor, Toshiba, or Reliance. Motor bearings shall be ball bearing and shall have lubrication connections.

F. Condenser
1. The condensing section shall be equipped with direct drive, vertical discharge condenser fan(s). The condenser coil shall be sloped at least 30 degrees from horizontal to protect the coil from damage. Provide condenser coil anti vandalism guards manufactured from 13 gauge steel expanded metal on each unit installed at the factory.

G. Filters
1. 4" thick, fiberglass, pleated with an ASHRAE efficiency of 30%. Face velocity not to exceed 500 FPM.

H. Evaporator Coils shall be constructed as follows:
1. Copper tube with aluminum fins mechanically bonded to the tubes.
2. Rated in accordance with ARI Standard 410.
3. Have galvanized steel end casings.
4. Have equalizing type vertical tube headers.
5. Furnished with a thermostatic expansion valve.

I. Refrigeration System
1. Compressors shall be scroll type with internal thermal overload protection and mounted on the compressor manufacturer's recommended rubber vibration isolators.
2. All units 8 tons and above shall be multiple stages with a minimum of 2 stages of capacity control.

3. Compressors shall be mounted in an isolated compartment to permit operation of the unit without affecting condenser air flow when the door to the compartment is open.

4. Compressors shall be isolated from the base pan and supply air to avoid any transmission of noise from the compressor into the building area.

5. System shall be equipped with thermostatic expansion valve type refrigerant flow control.

6. System shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant controls.

7. Unit shall be equipped with Schrader type service fittings on both the high side and low pressure sides of the system.

8. Unit shall be fully factory charged with refrigerant.

9. Options: (Multiple selections are permissible)
   a. All circuits shall be equipped with liquid line sight glasses.
   b. Unit shall be equipped with a 5 minute anti-short cycle delay timer for each stage.
   c. Unit shall be equipped with 20 second between stage delay timers for each stage.

J. Gas Heat Section

1. Unit shall heat using natural gas fuel and with a two stages of heat capacity.

2. Unit shall be provided with a gas heating furnace(s) consisting of an aluminized tubular steel heat exchanger with multiple concavities, an induced draft blower and an electric pressure switch to lockout the gas valve until the combustion chamber is purged and combustion air flow is established. Drum type heat exchangers or heat exchanger tubes with separate internal turbulators are not acceptable.

3. Unit shall be provided with a gas ignition system consisting of an electronic ignitor to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
   a. Unit shall be equipped with redundant gas valves and high limit cut-out.
   b. Unit shall have gas supply piping entrances in the unit base for through the curb gas piping and in the outside cabinet wall for across the roof gas piping.

4. The gas heat exchanger shall carry a 15 year non pro-rated warranty.

K. Controls

1. Provide controls system as indicated on controls drawing and plans. Dependent on controls layout furnish unit as follows:
   a. Smoke Detector (Only for units 2000 cfm and greater and per applicable code. See Equipment schedule)
   b. When scheduled unit shall be provided with a smoke detector sensing in the supply air wired to shut off the supply fan on detection of smoke.

L. Power Option

1. Unit shall be provided with a 115 volt ground fault service receptacle factory wired using transformer on the inside of the unit. (See Schedule For Locations). Division 16 shall provide connections to the transformer.
2.3 ROOF CURBS

A. Unit shall be mounted on a factory furnished fully welded, airtight, roof curb. Roof curbs shall be constructed of galvanized steel. Curbs are to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. All welds shall be complete to provide complete structural integrity.

2.4 ROOF SUPPLY AND RETURN PLENUM CURBS

A. Provide a horizontal discharge plenum manufactured of minimum 18 gauge galvanized steel fully welded and sealed airtight. Plenum shall be internally insulated and include separation baffle between supply and return air streams. All welds shall be complete to provide complete structural integrity.

END OF SECTION
DIVISIONS 24 – 25
NOT USED
SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE

A. Provide electrical systems as shown and specified, including wiring and connections to any electrical equipment provided and any work not specifically noted but that can be reasonably inferred or is necessary to provide a complete functional system.

B. Section Includes:
   1. Electrical equipment coordination.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   5. Common electrical requirements.

1.2 RELATED SECTIONS

A. Section 01 73 29 - Cutting and Patching
B. Section 01 33 23 - Shop Drawings, Product Data and Samples
C. Section 01 35 116 – Alteration Procedures
D. Section 02 41 00 – Demolition
E. Section 03 30 00 – Cast in Place Concrete
F. Section 07 92 00 - Joint Sealants
G. Section 07 84 00 – Fire Stopping
H. Division 21 – Mechanical Plumbing
I. Division 23 – Mechanical HVAC
J. Division 27 – Communications
K. Division 28 – Electronic Safety and Security
L. Division 31 - Earthwork

1.3 DEFINITIONS

A. EPDM: Ethylene-Propylene-Diene Terpolymer rubber.

B. NBR: Acrylonitrile-Butadiene rubber.
1.4 DRAWINGS AND SPECIFICATIONS

A. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, the Contractor shall make use of all data in all the contract documents and shall verify this information at building site.

B. Information presented on Drawings and in the Specifications is based upon latest data available during their preparation. The Drawings and Specifications are for the assistance and guidance of the Contractor and exact locations, distances, levels, etc. will be governed by the structures and the site the contractor shall accept same with this understanding.

C. The drawings indicate required size and points of termination of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of the Contractor to make the installation in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep openings and passageways clear.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall be responsible for delivery, storage, protection and placing of all equipment and materials.

B. Equipment stored and installed at the job site shall be protected from dust, water or other damage. Cover all equipment stored exposed to weather.

1.6 STRUCTURAL REQUIREMENTS

A. Structural members shall not be cut or modified in any manner without specific instructions from the structural engineer.

1.7 SEISMIC RESISTANCE

A. Provide systems, units, equipment, and parts to meet or exceed current applicable requirements for seismic resistance specified by codes, regulations, or agencies having jurisdiction. Include supports, anchors, braces, and other restraining devices required. Seismic restraints shall meet the local Seismic Zone requirements, SMACNA, and California Building Code (CBC), Chapter 16a, which are the responsibility of the Contractor.

B. Design of seismic bracing will be per CBC Chapter 16.

C. See Section 26 05 29 Hangers and Supports.

1.8 RULES AND REGULATIONS

A. All work and materials shall be in full accordance with the latest rules and regulations of California Code of Regulations, Title 20 & Title 24 California Building Standards Code, California Electrical Code, Local City and County Code, applicable regulations of local utility companies, E.U.S.E.R.C. Standards, and General Order 95 of the Public Utilities Commission, and any other applicable laws or regulations.
B. Nothing in these drawings or specifications is to be construed to permit work not conforming to the above codes.

1.9 PERMITS AND FEES

A. Obtain all permits and pay all required fees for permits and/or utility services. Inspections required during the course of construction shall be arranged as required. On completion of the work furnish the District’s representative with certificates of inspection.

B. Include in bid all costs for electrical service including meter, and service lines installed by a power utility company or a power utility company approved contractor.

1.10 SITE CONDITIONS

A. Assume all responsibility for damage to adjoining properties; and restore property to its original condition, should damage occur as a result of the work of this section. Contractor shall thoroughly familiarize himself with all site conditions. Should utilities not shown on the drawings be found during excavations, promptly notify the District’s Representative for instructions as to further action. Failure to do so will make the Contractor liable for any and all damage thereto arising from his operations subsequent to discovery of such utilities not shown on plans.

1.11 SUBMITTALS

A. Submit in accordance with Section 01 33 23 Shop Drawings, Product Data and Samples

B. General

1. A submittal schedule shall be issued by the Contractor within 15 days of award of the contract. This schedule shall allow for timely review and approval as required by the contract documents.

2. These requirements apply only to substitutions, submittals, and shop drawings.

3. The contractor shall review all submittals prior to submission to the Architect. Submittals not reviewed by the contractor will be returned to the contractor and will not be reviewed.

4. Any deviations from specified requirements shall be clearly indicated in submittals.

5. Any errors in or omissions from submittals and any consequences of these are the responsibility of the Contractor.

6. Partial or incomplete submittals may be rejected as not complying with requirements; the Contractor shall be liable for any resultant consequences.

7. Delayed submittals may be rejected as not complying with requirements. Whether accepted or rejected, delayed submittals will not be considered justification for extension of contract time or similar relief.

8. Submittals not required or permitted by the Specifications but made at the option of the Contractor, will be returned without review unless accompanied with written valid justification.
9. Submittal items improperly included with those of another category (such as a proposed substitution included with shop drawing submittal) are not valid and will be returned without review.

10. Within 35 calendar days after award of the contract, and before fabrications and installation of any material or ordering of any materials, submit for approval one copy in PDF format of complete submittal data on specified and proposed substituted equipment and materials. Submittals shall list all materials proposed identified with drawing symbols and specific data on equipment such as arrangements, performance curves, sizes, capacity, motor locations, and other pertinent data. Check all submittals for conformance to the requirements of the Construction Documents before forwarding to the District’s Representative for each item. No consideration will be given to substitutions submitted past 35 day limit. The contractor shall be responsible for all quantities and errors and omissions of submittals. Furnish samples when requested.

11. Equipment and materials specified as part of the specifications and drawings are listed by two manufacturers names. The first named manufacturer is the basis of design. The second named manufacturer has been determined to be an equivalent in quality or utility. The second named has not been specifically determined to conform to the first named in size, layout, electrical power, voltage, or impacts to building structure. The contractor is bound by all requirements for substitutes, as described below, for all second named manufacturers and equivalent equipment or products.

12. Each reviewed submittal will be marked to indicate review and directions as stated below.

13. Acceptance of a submittal does not relieve the Contractor of responsibility for omissions from the submittal or errors in the submittal

1.12 REVIEW

A. Submittals will be reviewed for general acceptability, not necessarily including all details. The engineers review is for general conformance with the design concept of the project and the information given in the contract documents. The contractor is solely responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating the work with that of other trades and performing all work in a safe and satisfactory manner. Corrections of comments made on this submittal during this review do not relieve contractor from compliance with the requirements of the contract documents or with its responsibilities listed herein.

1. Proposed substitutes will be judged not only for the acceptability of the items themselves, but also how they will be used under the conditions of the particular project.

2. Proposed substitutions will be judged also for compliance with qualifications and conditions stipulated in paragraph 1.15.

B. Each reviewed submittal will be marked to indicate review and directions as stated below.

1. Acceptance of a substitute does not waive the specified requirements.

2. Once a substitution is accepted, no revision or resubmittal may be made except for pressing and valid reason and after receipts of approval to do so.

1.13 REVIEW DIRECTIONS

A. The notation "No Exceptions Taken" indicates that no further submittal on the particular matter is required and that the Contractor may proceed with normally ensuing action. The notation may be applied to submittals on substitutions, shop drawings, record data, or
operation and maintenance data. The submittal has only been reviewed for general conformance with the design concept of the Contract Documents. The contractor is responsible for the dimensions to be confirmed and correlated at the job site; information that pertains solely to the fabrication process or to the means and methods of construction; coordination of the work of all trades; and performing all work in a safe and satisfactory manner. This notation does not modify the contractor's duty to comply with the contract documents.

B. The notation "Make Corrections Noted" indicates that no further submittal on the particular matter is required, but the Contractor shall make all changes or corrections noted (but no others) before proceeding with normally ensuing action. The notation may be applied to submittals on substitutions or shop drawings (but usually not record data or operation and maintenance data).

C. The notation "Amend and Resubmit" indicates that the submittal is not accepted and must be revised, resubmitted, and reviewed again. In the case of submittal on substitutions and shop drawings so noted, the Contractor shall not proceed with any normally ensuing action until the resubmittal is reviewed. The notation may be applied to submittals on substitutions, shop drawings, record data, or operation and maintenance data.

D. The notation "Rejected - See Remarks" indicates that the submittal is not accepted and that resubmittal on the same subject matter is not allowed and will not be considered. The notation will be applied normally only to submittals on substitutions (usually not on shop drawings, record data, or operation and maintenance data).

E. The notation "Returned Without Review" indicates that the submittal or item has not been considered officially because it is either not proper, valid, required, or permitted by the Specifications and has no status or effect.

1.14 SHOP DRAWINGS

A. The contractor is responsible for providing all shop drawings as described below so that the design professional has the opportunity to determine if the contractor understands the contract documents. It is not the purpose of shop drawings to assure that the contractor is meeting the requirements of the contract documents. Review and approval of a submittal neither extends nor alters any contractual obligation.

B. Accompany all substituted equipment with shop drawings showing revised equipment and/or equipment layouts in order to ascertain that substituted equipment does not adversely affect layout or work of others. Shop Drawings: The following conditions apply to shop drawings:

1. Shop drawings are not and do not become Contract Documents.

2. Processed shop drawing submittals and any instructions or requirements noted thereon are a part of the work, but they may not be used as a means of increasing the scope of the work.

3. If deviations, discrepancies, or conflicts between shop drawing submittals and the Contract Documents are discovered either prior to or after the submittals are processed, the Contract Document requirements shall govern.
1.15 SUBSTITUTIONS

A. Whenever any equipment, material, or process is indicated or specified by patent of proprietary name and/or name of Manufacturer, in the Specifications and/or on the Drawings, it is understood that such specification is used to facilitate the description of the material and/or process and deemed to be followed by the words "or equal" unless noted "no substitute".

B. Substitute equipment and materials shall be equal in all respects including quality, arrangement, utility, physical size, capacity, and performance to those specified. Approval of substitute material will not relieve the contractor from complying with the requirement of the Drawings and Specifications. The contractor shall be responsible and at his own expense, for any changes caused by proposed substitutions which affect other parts of his own work or the work of other contractors.

C. The submittal of a proposed substitution shall clearly establish the following:
   1. The item can be transported into and installed in the intended space and in the manner shown.
   2. Required connections (electrical and other) can be properly made and adjoining work can be properly accomplished.
   3. The proposed substitute is similar to and of substance equal to that specified, is suited to the same use as that specified, and will perform the functions required by the design.
   4. The proposed substitute equipment will have the same minimum ratings and dimensions that accommodate the available space as the specified equipment.
   5. All performance requirements shall be at least equal to the specified product or equipment including short circuit current rating, selective coordination, noise levels, temperature ratings, bracing and insulation ratings, etc.

D. By submitting a proposed substitution, the Contractor agrees to the following:
   1. He will assume full responsibility for any and all modifications and necessary alterations arising from the use of the substitute item or material including all cost incurred by all other trades.
   2. He will assume full responsibility for any delay in the construction schedule resulting from the use of the substitution.
   3. He will prove harmless and indemnify the District and the District's design consultants from real or alleged damages that may result from the installation, use, or performance of a substitute material or product.

E. The following conditions apply to substitutions:
   1. Submittals of substitutions are not and do not become part of the Contract Documents.
   2. Contractor shall not order, fabricate, use, or install any substitute product or procedure unless he has received acceptance of the substitute from the District's Representative.
   3. Should the Contractor install any substitute product in violation of the above he shall remove it and install the specified product at his own expense.
   4. The Contractor shall provide a letter stating that all the above items shall apply to all substituted products and equipment.
   5. Any submittal for substituted equipment or product that does not clearly show that the substituted item is equal shall be marked rejected and no further submittal shall be
allowed on the substituted item. Provide in submittal format documentation that the proposed item is exactly as specified in the contract documents.

1.16 INSTALLATION

A. Manufacturer's Instructions:
   1. When specifications require that installation comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation.
   2. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by specifications.
   3. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.
   4. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with the District's Representative for further instructions.
   5. Do not proceed with work without clear understanding.

1.17 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other systems.
   3. To allow right of way for piping and conduit positioned at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate placement of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

1.18 WORKMANSHIP

A. Good workmanship shall be evidenced in the placement of all electrical materials and equipment. Equipment shall be level, plumb and true with the structure and other equipment. All materials shall be firmly secured in place and adequately supported and permanent. The requirements of the codes are minimum standards. The recommendations of the National Electrical Contractors Association Standards shall be followed except where otherwise specifically directed.

1.19 CLEANING

A. After all other work such as plastering, painting, etc., has been accomplished, lighting, panelboards, switchboards, and all other electrical equipment shall be cleaned of all dirt, grease, plaster, paint or other marks.
1.20 ELECTRICAL WORK FOR EQUIPMENT PROVIDED BY OTHER DIVISIONS

A. Provide all necessary electrical connections to all equipment provided by other divisions. Obtain specific power and control wiring requirements and connection points from others to perform electrical work. Contractor shall assist in testing equipment but responsibility is limited to correctly wiring and terminating electrical connections.

B. All control wiring for mechanical space conditioning and ventilation equipment, both line and low voltage, shall be provided in the mechanical work, except for line voltage control wiring for exhaust fan switches which shall be in the electrical work. Disconnect switches and motor starters shall be provided.

1.21 SEISMIC RESISTANCE

A. Provide systems, units, equipment, and parts to meet or exceed current applicable requirements for seismic resistance specified by codes, regulations, or agencies having jurisdiction. Include supports, anchors, braces, and other restraining devices required. Seismic restraints shall meet the local Seismic Zone requirements, SMACNA, and California Building Code (CBC), Chapter 16a, which are the responsibility of the Contractor.

B. Design of seismic bracing will be per CBC Chapter 16.

1.22 MISCELLANEOUS EQUIPMENT

A. Contractor shall provide conduit, conductors, disconnects, and connections for power and controls for equipment requiring electrical services. This includes materials required for temporary services and testing.

1.23 GUARANTEE

A. Guarantee all work for one year from date of acceptance, against all defects in material, equipment and workmanship including repair of damage to any part of the premises resulting from leaks or other defects in material, equipment and workmanship. Guarantee shall be on form supplied by the District's representative.

1.24 RECORD DRAWINGS

A. Changes including the result of RFI's or field directives shall be included in a record set provided by the Contractor in an electronic format compatible with system used to produce the original contract drawing set. Provide a copy of the marked-up field set along with the electronic file. It will not be acceptable to cut and paste the drawing changes to this set.

PART 2 - PRODUCTS

2.1 SHOP DRAWINGS:

A. Make all drawings to an appropriate scale, large enough to show all pertinent aspects of the item and the method of its connection into the work.

B. Make each drawing sheet in a reproducible form, CAD, Revit or PDF.

C. Grouping: Combine submittals in logical groupings; for example, submit Shop Drawings grouped by Sections of the Specifications, arranged in the specified sequence.
D. Content:
   1. Shop drawings may be:
      a. Drawings or diagrams prepared by the Contractor, a supplier, a manufacturer, or other.
      b. Typewritten data or descriptions.
      c. Manufacturer’s printed brochures, descriptions, charts, instructions, or data sheets.

E. Timing: Submit all shop drawings prior to installation of any items included in submittal.

2.2 MATERIALS

A. Unless otherwise noted, all material and equipment shall be new, of the type, capacity and quality specified and free from defects. Material shall bear the label of, or be listed by, the Underwriters’ Laboratories or Nationally Recognized Testing Laboratory (NRTL).

B. Materials shall be of the same brand or manufacture throughout for each class of material or equipment wherever possible.

C. Equipment shall be the product of a manufacturer who has, for a period of not less than five (5) years, been in successful manufacture of the equipment and who has a nationally distributed catalog covering ratings and specifications of said equipment.

2.3 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.4 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers:
      a. Calpico, Inc.
      b. Advance Products & Systems, Inc.
      c. Pipeline Seal and Insulator, Inc.
      d. Or, Equal.

   2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

   3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 GROUT

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

2.6 ACCESS DOORS

A. Unless specified otherwise by the Architect, provide access doors of the following type:
   1. Concealed hinges, prime coated with rust-inhibitive paint, style of door to suit wall, ceiling, floor or roof construction and fire rating.
      a. Milcor Type M
         1.) Architectural grade, one-piece frame, 16 gauge frame & door panel on concealed spring hinges, grey powder coated steel, Elmdor/Stonman or equal.
      b. Milcor Type UFR, fire resistive type Underwriters Laboratory Class B, 1-1/2 hour rating meets UBC, IBCO and BOCA codes for two hour rated walls self latching with key lock, Elmdor/Stonman Type FR or equal.

   2. Minimum size; 18" by 18".

   3. Wall and ceiling access doors: Furnish as required for access to fire alarm devices, devices requiring access for adjustment, battery packs, etc.; coordinate size and location to obtain access.

   4. See architectural drawings for further requirements.

2.7 MISCELLANEOUS EQUIPMENT AND MATERIALS

A. Furnish and install miscellaneous equipment and materials required for the systems described whether or not specifically shown.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL

A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, locate components and equipment to provide maximum possible headroom consistent with these requirements.

   1. Adequate working space shall be provided around electrical equipment in strict compliance with the Electrical Safety Orders. In general provide six and one-half feet of headroom and thirty-six inches minimum clear work space in front of panelboards and controls for 120/208 volt equipment, and forty two inches for 277/480 volt equipment.

C. Equipment: Placement shall facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby infrastructure. Connect in such a
way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

D. Right of Way: Give to piping systems with slope requirements.

3.2 SLEEVES FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Provide sleeves for penetrations unless core-drilled holes or formed openings are used. Provide sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Provide sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with Firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves penetrating floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 070690 "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Provide sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Section 07 84 00 – Fire Stopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Above ground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve and provide mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Provide cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve and provide mechanical sleeve seals.
3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical infrastructure to restore or maintain fire-resistance rating of assembly. Firestopping materials and execution requirements are specified in Section 07 84 00 – Fire Stopping.

3.4 FIELD QUALITY CONTROL

A. Test all wiring and connections for continuity and grounds before any fixtures or equipment are connected and where such tests indicate faulty insulation or other defects, they shall be located, repaired and tested again at the Contractor’s expense. Electrical loads shall be balanced at the panelboards and motors shall be checked for correct rotation.

B. Third party acceptance testing is required as part of this project. Contractor to provide the services of a NETA certified testing contractor to perform testing of equipment identified in the respective specification sections. Submit test reports noting acceptance, test values and a baseline for future test readings.

C. Notify District’s Representative in advance prior to project completion. At such time, arrange an operating test for approval and/or schedule for electrical apparatus testing by a third party testing company. Demonstrate equipment to be in conformance with applicable Codes and operate in accordance with Requirements of this Section of the Specifications. Provide all instruments and personnel required for test.

D. In the absence of manufacturer’s torque values refer to Table 1 herein.

Table 1

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3.5 SALVAGE MATERIAL AND EQUIPMENT

A. Where remodel or demolition work is to be accomplished under this Contract, all removed materials and equipment, which in the opinion of the Owner is salvable, shall remain the property of the Owner. Such salvaged materials and equipment shall be delivered to Owner on premises as directed and shall be neatly piled or stored and protected from damage.
B. All materials considered as scrap and not salvageable shall be removed from premises and disposed of by Contractor.

3.6 DEMOLITION

A. When devices are removed that are located midway in a circuit maintain continuity of the circuit and accessibility of any junction boxes.

B. When the scope of work requires the removal of electrical equipment all associated conduit, conductors, boxes, hangers, anchors, etc. shall be removed in their entirety. All openings shall be patched and sealed to match the adjacent construction and finish including the replacement of floor tiles.

C. Damaged floor and ceiling tiles shall be replaced.

END OF SECTION
SECTION 26 05 13
MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 DEFINITIONS


1.4 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

B. Qualification Data: For Installer and testing agency.

C. Material Certificates: For each cable and accessory type, signed by manufacturers.

D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2 and NFPA 70.
1.6 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify the District’s Representative no fewer than ten days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without District Representative’s written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cables:
   a. Okonite Company (The).
   b. General Cable Technologies Corporation.
   c. Kerite Co. (The), Marmon Utility LLC.
   d. Prysmian Cables & Systems, Prysmian Group (Formerly Pirelli Cables & Systems NA.)
   e. Southwire Company.
   f. Or, Equal.

2. Cable Splicing and Terminating Products and Accessories:
   a. 3M; Electrical Products Division.
   b. Cooper Industries, Eaton
   d. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
   e. RTE Components; Cooper Power Systems, Inc.
   f. Thomas & Betts Corporation/Elastimold.
   g. Or, Equal.

2.2 CABLES

A. Cable Type: MV105.

B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682.

C. Conductor: Copper.

D. Conductor Strandling: Compact round, concentric lay, Class B.

E. Strand Filling: Conductor interstices are filled with impermeable compound.

F. Conductor Insulation: Ethylene-propylene rubber.
1. Voltage Rating: 15 kV.
2. Insulation Thickness: 133 percent insulation level.

G. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

H. Cable Jacket: Sunlight-resistant PVC.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

2.4 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
   1. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
   2. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
   3. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.

2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.

3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.


E. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
   1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
   2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Support cables according to Division 26 Section "Common Work Results for Electrical."

E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
F. Install cable splices at pull points and elsewhere as indicated; use standard kits.

G. Install separable insulated-connector components as follows:
   1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

H. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
   1. Clean cable sheath.
   2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
   3. Smooth surface contours with electrical insulation putty.
   4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
   5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

3.2 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. Section includes:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.2 RELATED SECTIONS

A. Section 260526 Grounding and Bonding
B. Section 260529 Hangers and Supports
C. Section 260533 Raceway and Boxes
D. Section 260553 Identification
E. Section 262200 Low Voltage Transformers
F. Section 262413 Switchboards
G. Section 262416 Panelboards
H. Section 262816 Enclosed Switches & Circuit Breakers
I. Section 265100 Interior Lighting
J. Section 280513 Conductors and Cables for Electronic Safety and Security

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.
C. NEMA: National Electrical Manufacturer’s Association

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For each type of product indicated.
C. Manufacturer’s cable pulling tension data to be on site for Inspector’s and/or Engineer’s reference.
D. Field quality-control test reports.
1.5 QUALITY ASSURANCE

A. All conductors and cable shall comply with the applicable standards of Underwriter’s Laboratories, Inc.

B. Testing of conductors and cables by Contractor.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers:
   1. Southwire Company.
   2. General Cable Corporation.
   5. American Insulated Wire Corp.
   7. Or Equal

B. Copper Conductors: Comply with NEMA WC 70 – Power cables rated 2000 volts or less.
   1. All conductors shall be stranded copper, 98 percent conductivity.
   2. Stranded Copper, #10 AWG minimum, except for control circuits which may be #14 AWG minimum. Signal and control circuits other than mechanical shall be as indicated on Drawings or as required by equipment manufacturers.
   3. Conductors in sizes up through #10 AWG shall have solid color finish as listed above. #8 AWG and larger shall be color coded by application of phase tape for minimum of 6" length on conductor. Coding shall occur at all terminations, pull boxes and splices.
   4. Color-coding shall be continuous and consistent throughout the work. Do not use different colors for switch legs, fixture taps, travelers, etc.
   5. Phasing: Terminals in panelboards, motor control centers, switchboards and other equipment shall be phased A, B, C, reading left to right or top to bottom looking into the front of the equipment.

C. Conductor Insulation: Comply with UL 83 for Types THW, THHN/THWN-2, THWN-2, XHHW-2, UF, USE, and SO.
   1. All insulation shall be 600 V, 90 degrees Centigrade minimum except for low voltage 50 volts and less.
   2. Fixture tap and branch circuit wiring within fixture wireways shall be Type THHN 90 degrees Centigrade. Control wiring #14 and smaller shall be Type THHN/THWN. Insulation for bonding and grounding conductors shall be Type THWN except as noted on the Drawings.
   3. All conductors, unless noted in the Drawings otherwise, shall be Type THHN/THWN-2.
D. Multi-conductor Cable: Comply with UL 83 for metal-clad cable, Type MC with ground wire independent of metal sheath.

1. Type MC cable is not permitted for general use in this project. See Execution below for limited use.

E. Cable Ties: For wire training and clamping in cabinets and enclosures use nylon cable ties.

2.2 CONNECTORS AND SPLICES

A. Manufacturers:

1. Burndy, Inc.
2. O-Z/Gedney; Emerson Electrical Automation.
4. TE Connectivity.
5. 3M; Electrical Products Division.
6. Or Equal

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

1. Splices for conductors #8 AWG and smaller use pre-insulated pressure type (with live spring) rated 105 degrees Centigrade, 600 V for building wire and 1000 V in signs or fixtures.
2. Splices for conductors #6 AWG and larger use compression type connector, Burndy type YS long barrel or equal, requiring the use of a 360 degree circumference compression type tool. Wire splicing devices shall be sized according to manufacturer’s recommendations.
3. Compression splices shall be insulated with a tape wrap using Scotchtape No. 88 or equal.
4. Use Scotchfill or equal around large or irregular shape splices for insulation build-up and Scotchtape No. 88 or equal.
5. In outdoor locations and below grade all sizes shall be compression type with heat shrink style watertight splice covers.
   a. Splices in underground pull boxes or in other areas subject to moisture shall be provided with cast resin kits and cadweld or compression type connections, Burndy type YS long barrel. Use Scotchlok sealing packs for wire size to #10 and Scotchcast kits for larger splices as recommended by 3M Company. All splices to be prepared as hereinbefore specified before resin kits are applied. Wire splicing devices shall be sized according to manufacturer's recommendations.
6. MC cable connectors: Insulated throat MC cable connector with threaded box connection and barrel style connection to the cable armor. Snap-on type connectors will not be accepted.
   a. Acceptable products:
      1) Arlington Cat. No. 38A
      2) RACO saddle/screw type Cat No. 2800
      3) Or, Equal.
2.3 FIXTURE WHIPS
   A. See section 26 51 00 Interior Lighting.

2.4 SLEEVES FOR CABLES
   A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
   B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

2.5 SLEEVE SEALS
   A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
      1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
      2. Pressure Plates: Carbon steel. Include two for each sealing element.
      3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 WIRING PULLING LUBRICANT
   A. Minerallac Pull-in compound, Y-ER-EAS wire pulling lubricant, Poly-water, or other UL Listed lubricant. Flax soap is not approved.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS
   A. Color code all branch circuits and feeders as noted in Section 260553 Identification.

3.2 CONDUCTOR INSULATION AND MULTICOCONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
   A. Exposed & Concealed Feeders: Type THHN-THWN-2, single conductors in raceway.
   B. Exposed & Concealed Branch Circuits: Type THHN-THWN-2, single conductors in raceway.
   C. Code size ground wire shall be provided in all raceways, secured using approved methods to each pull box, junction box, and equipment housing.
   D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain-relief device at terminations to suit application.
   E. Class 1 and Class 2 Control Circuits: Type THHN-THWN, in raceway.
   F. Branch circuits and feeders in conduit exposed to direct sunlight: Type XHHW-2.
G. Motor feeders/branch circuits sourced from a variable frequency drive: Type XHHW-2 from the drive unit to the motor.

H. Store front framing assemblies: Where necessary to power devices through store front framing assemblies such as exit signs, ADA push buttons, electrified door hardware, etc., it is permissible to use MC cable.

3.3 CONDUCTORS AND CABLES

A. All wiring shall be in raceways.

B. Swab conduits before installing cables, and exercise care in pulling to avoid damage or disarrangement of conductors.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

E. Mount exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 Hangers and Supports.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B or refer to Table 1 in Section 26 05 00 Common Work Results for Electrical.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Feeder conductor splices 60 amp and larger.

1. Use compression style connectors for butt splices with no more than 1/8-inch conductor shiner. Splices using mechanical style connectors such as “Polaris Connectors” will be rejected.

2. Follow NETA test procedures testing each splice with a milli-volt drop test or micro-ohm meter. Any phase exceeding 50% of the lowest resistance value obtained shall be considered as a failed splice condition. Failed splices shall be removed and the conductors re-spliced.

D. Wiring at Outlets: Provide conductor pigtails at each outlet, with at least 6 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
B. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

C. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
   2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

D. Cut sleeves to length for mounting flush with both wall surfaces.

E. Extend sleeves installed in floors 2 inches above finished floor level.

F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

H. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

I. Above ground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. After conductors and cables are placed and before electrical circuitry has been energized, test each conductor including the neutral with respect to ground and adjacent conductors before connecting to equipment.
      a. Megger and record insulation resistance of all 600 volt insulated feeder conductors, size #2 AWG and larger using a dc megger for 1-minute set at 500 volts DC for 208 volt systems and 1000 volts DC for 480 volt systems. Make tests with circuits isolated from source and load.

   2. Perform continuity test on all power equipment branch and feeder circuit conductors. Verify proper cable connection and phasing.

   3. Minimum insulation resistance values shall not be less than 50 megaohms.
C. Test Reports: Prepare a written report with baseline data to be included in the O&M manual to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION
SECTION 26 05 23

CONTROL VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SCOPE

A. Section includes low voltage cabling for controls

1.2 RELATED DOCUMENTS

A. Section 017800 Close Out Submittals
B. Section 061000 Rough Carpentry
C. Section 260533 Raceway and Boxes
D. Section 260553 Identification
E. Section 260923 Lighting Control Devices
F. Section 260943 Network Lighting Controls
G. Section 265100 Interior Lighting

1.3 SUMMARY

A. Section Includes:
   1. UTP
   2. RS-485 cabling.
   3. Low-voltage control cabling.
   5. Identification products.

1.4 DEFINITIONS

A. EMI: Electromagnetic interference.
B. IDC: Insulation displacement connector.
C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
D. RCDD: Registered Communications Distribution Designer.
E. UTP: Unshielded twisted pair.
F. TIA/EIA. Telecommunications Industry Association cabling standards
G. NRTL. Nationally Recognized Testing Laboratory.
H. BICSI. Building Industry Consulting Service International
I. RCDD. Registered Communications Distribution Designer
J. NECA. National Electrical Contractor's Association
K. UL. Underwriter's Laboratory
L. TDMM. Telecommunications Distribution Methods Manual

1.5 SUBMITTALS
A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For each type of product indicated.
C. Qualification Data: For qualified layout technician, Placement supervisor, and field inspector.
D. Source quality-control reports.
E. Field quality-control reports.
F. Maintenance Data: For wire and cable to include in maintenance manuals in accordance with Section 017800 Close-out Submittals.

1.6 QUALITY ASSURANCE
A. Testing Agency Qualifications: Member company of an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Test cables upon receipt at Project site.
   1. Test each pair of UTP cable for open and short circuits.

1.8 PROJECT CONDITIONS
A. Environmental Limitations: Do not provide UTP and optical fiber cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS
A. Conduit and Boxes: Comply with requirements in Section 260533 Raceway and Boxes for Electrical Systems. Flexible metal conduit shall not be used.
1. Outlet boxes shall be no smaller than 4 inches wide, 4 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, ¾ inches by 48 inches by 96 inches. Comply with requirements for plywood backing panels in Section 061000 Rough Carpentry.

2.3 UTP CABLE

A. Manufacturers: Basis of design is Superior Essex, Inc.
   1. Superior Essex Inc.
   2. Belden CDT Inc.; Electronics Division.
   3. Berk-Tek; a Nexans company.
   4. Mohawk; a division of Belden CDT.
   5. Genesis Cable Products; Honeywell International, Inc.
   6. KRONE Incorporated.
   7. Nordex/CDT; a subsidiary of Cable Design Technologies.
   8. SYSTIMAX Solutions; a CommScope, Inc. brand.
   9. 3M.
   10. TE Connectivity/AMP Netconnect.
   11. Or, Equal.

B. Telephone backbone cable basis of design: Provision for Superior Essex Filled ASP ANMW No. 24 AWG 25-pair, 22-097-83 copper cable, or equal.

C. Inside Station copper cable: 100-ohm, four-pair UTP, formed into paired groupings as noted in the drawings with binder groups covered with a blue thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   3. Comply with TIA/EIA-568-B.2, Category 5e.
   4. 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 CMP
      b. Communications, Limited Purpose: Type CMX

2.4 UTP CABLE HARDWARE

A. Manufacturers:
   1. Hubbell Premise Wiring.
   3. Dynacom Corporation.
   4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
11. Or, Equal.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110 style for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 percent spare; integral with connector bodies, including plugs and jacks where indicated.

2.5 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM
   1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Fluorinated ethylene propylene jacket.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. Two pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.

2.7 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway.
B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.8 IDENTIFICATION PRODUCTS

A. Manufacturers:
   1. Brady Corporation.
   2. Panduit Corp.
   3. Kroy LLC.
   4. Or, Equal.

B. Comply with requirements in Section 260553 Identification.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 PLACEMENT OF PATHWAYS

A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Section 260533 Raceway and Boxes for Placement of conduits and wireways.

C. Provide manufactured conduit sweeps and long-radius elbows.

D. Pathway Placement in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is provided or in the corner of room if multiple sheets of plywood are provided around perimeter walls of room.
   2. Provide cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering room from overhead.
   4. Extend conduits 3 inches above finished floor.
   5. Provide metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Provide backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.
3.2 PLACEMENT OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Provide lacing bars and distribution spools.
   5. Do not provide bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during Placement and replace it with new cable.
   6. Cold-Weather Placement: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   7. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Placement:
   2. Provide 110-style IDC termination hardware unless otherwise indicated.
   3. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Placement of Control-Circuit Conductors:
   1. Provide wiring in raceways. Comply with requirements specified in Section 260533 Raceway and Boxes.

E. Open-Cable Placement:
   1. Provide cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.


3.3 REMOVAL OF CONDUCTORS AND CABLES
A. Remove abandoned conductors and cables.

3.4 CONTROL-CIRCUIT CONDUCTORS
A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits, No 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits, No. 18 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 FIRESTOPPING
A. Comply with requirements in Section 078400 Firestopping.

3.6 GROUNDING
A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 260526 Grounding and Bonding.

3.7 IDENTIFICATION
A. Comply with requirements for identification specified in Section 260553 Identification.

3.8 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION
SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SCOPE

A. Section includes:
   1. Grounding systems and equipment.

1.2 RELATED SECTIONS

A. Section 260519 Conductors and Cables
B. Section 260553 Identification
C. Section 262200 Low Voltage Transformers
D. Section 262413 Switchboards
E. Section 262416 Panelboards
F. Section 271100 Communications Equipment Rooms
G. Section 280513 Conductors and Cables for Electronic Safety and Security
H. Section 283111 Digital, Addressable Fire Alarm System

1.3 DEFINITIONS

A. NETA: International Electrical Testing Association
B. NRTL: Nationally Recognized Testing Laboratory
C. NEMA: National Electrical Manufacturer’s Association
D. ASTM B 3: Standard Specification for Soft or Annealed Copper Wire
E. ASTM B 33: Standard Specification for Tinned Soft or Annealed Copper Wire

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For each type of product indicated.
C. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.

D. Qualification Data: For qualified testing agency and testing agency’s field supervisor.

E. Field quality-control reports.

F. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells ground rings grounding connections for separately derived systems based on NETA MTS.
   a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
   b. Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Contractor to perform testing per NETA standards.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code and authority having jurisdiction.

B. Bare Copper Conductors:
   2. Tinned Conductors: ASTM B 33.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced for NEMA 2-hole drilling. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 GROUND ELECTRODES

A. Copper clad steel rods, 3/4 inch diameter by 10 feet (unless noted otherwise in the drawings) with pointed end, driven to a depth where the rod top is accessible inside a ground well box with lid closed.

B. Metallic Piping: A connection to the interior metal piping system.

2.3 GROUND BUSES

A. Provide a ground bus at each service distribution panel for joining the ground connections.
2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to the District’s Representative for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least 2 bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. To Ground Rods: Exothermic weld, Cadweld or equal, utilizing weld molds of the type and size recommended by the weld manufacturer.

D. To Ground Buses and to Equipment: Pressure indented copper cable terminal, 2 hole: Burndy HYLUG, T&B Blue, or equal. Provide with inch stainless or cadmium plated steel machine bolts with beveled washer on each side.

E. Ground Cable Splices: Exothermic weld, Cadweld, or equal, utilizing molds of the type and size recommended by the weld manufacturer.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Provide stranded conductors unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG solid minimum.
   1. Bury at least 30 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 2 inches minimum from wall, 72 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

D. Conductor Terminations and Connections:
   1. Pipe Conductor Terminations: Bolted mechanical clamps listed for the application.
   3. Underground Connections: Welded connectors or as otherwise indicated in the drawings.
   5. Connections to Structural Steel: Welded connectors.
3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 2 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches (Medium Voltage stepped down to low voltage): Install two ground rods and ground ring around the pad (RUS system). Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG, unless noted otherwise in the drawing details, for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Provide insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.


3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 GROUND ELECTRODES

A. Protect rod top with a driving tool while driving to prevent deformation or other damage.
B. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
   1. Test Wells: Install at least one test well for each ground rod at each service unless otherwise indicated. Set top of test well flush with finished grade or floor.

3.5 INSTALLATION

A. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

B. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

D. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor encased not smaller than shown on the drawings. Minimum encasement is 2-inches.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.6 CONDUCTOR ROUTING

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
3.7 LABELING

A. Comply with requirements in Section 260553 Identification for instruction signs. The label or its text shall be green.

B. Label service grounds per type within switchboards and distribution panels.

C. Place labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
   1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the District's Representative."

3.8 FIELD QUALITY CONTROL

A. Contractor to provide the services of an independent testing agency to inspect, test, and adjust components, assemblies, and equipment placement, including connections.

B. Tests and Inspections:
   1. After placement of grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Grounding test shall be by fall of potential method.
   4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports for review by the District's representative and to be included as baseline data in the O & M Manual.

E. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 KVA and less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 KVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 KVA: 3 ohms.
   5. Manhole Grounds: 10 ohms.
F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify District's Representative promptly and include recommendations to reduce ground resistance.

END OF SECTION
SECTION 26 05 29
HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SCOPE

A. Section includes:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 RELATED SECTIONS

A. Division 3 Concrete
B. Section 260519 Conductors and Cables
C. Section 260533 Raceway and Boxes
D. Section 260548 Vibration and Seismic Controls
E. Section 262413 Switchboards
F. Section 262416 Panelboards
G. Section 262816 Enclosed Switches and Circuit Breakers
H. Division 28 Electronic Safety and Security

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.
B. IMC: Intermediate Metal Conduit.
C. RMC: Rigid Metal Conduit.
D. MFMA-4: Metal Framing Manufacturers Association Standards for Metal Framing Channels
E. NECA 1: National Electrical Contractors Association Standard Practice of Good Workmanship
F. NECA 101: National Electrical Contractors Association Standard for Installing Steel Conduits
G. MSS SP 58: Manufacturers Standards Society, Standards for Materials, Design, Manufacture, Selection, Application and Installation
I. ASTM A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
1.4 PERFORMANCE REQUIREMENTS
A. Seismic bracing shall meet requirements of CBC Chapter 16A.

1.5 SUBMITTALS
A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For the following:
   1. Steel slotted support systems.

1.6 QUALITY ASSURANCE
A. Comply with NFPA 70.

1.7 COORDINATION
A. Coordinate placement of conduit and equipment supports.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers:
      a. Cooper B-Line, Inc.; a division of Cooper Industries.
      b. ERICO International Corporation.
      c. Allied Tube & Conduit
d. Thomas & Betts Corporation.
e. Unistrut; Tyco International, Ltd.
f. Or equal
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer’s standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Available Manufacturers:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Hilti Inc.
      3) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      4) Or equal
2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Hanger Rods: Threaded steel, 1/2 inch minimum.

PART 3 - EXECUTION

3.1 APPLICATION

   A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/2 inch in diameter.

   B. Multiple Raceways: Provide trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

       1. Secure raceways to these supports with 2-bolt conduit clamps.

3.2 SUPPORTS

   A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 Pounds.

   B. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

       1. To New Concrete: Bolt to concrete inserts.

       2. To Existing Concrete: Expansion anchor fasteners.

       3. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

       4. To Light Steel: Sheet metal screws.

       5. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
C. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 PAINTING

A. Touchup: Clean abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean bolted connections and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 26 05 33
RACEWAY AND BOXES

PART 1 - GENERAL

1.1 SCOPE

A. Section includes:
   1. Raceways
   2. Fittings
   3. Boxes
   4. Enclosures
   5. Cabinets for electrical wiring

1.2 RELATED SECTIONS

A. Section 099100 Painting
B. Section 260519 Conductors and Cables
C. Section 260523 Control Voltage Electrical Power Cables
D. Section 260529 Hangers and Supports
E. Section 260553 Identification

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. RMC: Rigid metal (steel) conduit
C. LFMC: Liquid tight flexible metallic conduit
D. PVC: Poly Vinyl Chloride – SCH 40
E. NFPA 70: California Electrical Code, 2016 Edition

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authority having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. EMT:
   1. Shall be galvanized steel, thin wall. Maximum trade size to be used shall be 4 inch. May not be used underground, under floor, exposed to weather, in concrete, or in any location subject to physical damage.
   2. Connectors shall be steel rain-tight compression type requiring the tightening of a nut, with insulated throat. Couplings shall be steel rain-tight compression type, requiring the tightening of a nut up to 2 inches. Fittings larger than 2 inches shall be threaded type.

B. RMC:
   1. Standard weight, mild steel pipe, heavy wall, with threaded fittings, zinc coated on both inside and outside by a hot dipping or sherardizing process. Conduit fittings finished to same requirements as for rigid steel conduit.
   2. Conduit fittings finished to same requirements as for rigid steel conduit. All couplings, unions and fittings threaded type. Compression type fittings are not acceptable.
   3. Elbows: Shall be factory made with a minimum radius of 6 times the trade size.
   4. Apply thread sealant to all joints except in permanently dry locations.
   5. Termination of conduits, wiring gutters or boxes shall be fitted with steel locknut and insulated metallic bushing or with 2 steel locknuts and insulating bushings. When grounding bushings are required, use insulated grounding bushing. Where conduit connections are exposed to weather or excessive moisture they shall be fitted with insulated watertight sealing hub; i.e., Myers Hub or equal.
   6. All cut ends of conduit shall be reamed to remove rough edges where conduit is threaded in the field; an electrical conduit thread cutting die with a taper shall be used.

C. LFMC: Flexible steel conduit with PVC jacket
   1. Shall be galvanized steel with minimum trade size of ½ inch. In wet and corrosive locations, outside, or motor connections, shall be liquid-tight. May be used to connect recessed lighting fixtures or mechanical controls and equipment. Length shall be kept to a minimum but to allow for movement or removal of equipment. Leave slack in flex connection to maintain flexibility of conduit, minimum of 3 feet of flex and one 90 degree bend.
   2. Connectors shall be tile-bite type with insulated throat Crouse-Hinds Series ACB or T & B Series 3110; connectors for liquid-tight shall be with insulated throat Crouse-Hinds Series LTC or T & B Series 5331 with sealing "O"-ring at outside of enclosure.

D. Pull Lines: Provide 1/8 inch diameter yellow poly line pull line in empty conduits 1 inch and smaller and 3/16 inch polypropylene rope in conduits 1-1/4 inch and larger.

E. Joint compound for RMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.
F. Conduit Straps: 2 hole steel snap-on type with ribbed back or malleable iron with galvanized or cadmium plated finish. Secure straps with metal screws or machine screws and bolts on metal material, and expansion shields with machine screws on concrete or solid masonry. Use of nail straps or perforated strap iron is prohibited.

2.2 NONMETALLIC CONDUIT

A. Manufacturers:
   1. Carlon
   2. Amco Corporation.
   3. CANTEX Inc.
   6. ElecSYS, Inc.
   7. Lamson & Sessions; Carlon Electrical Products.
   8. RACO; a Hubbell Company.
   10. Or, Equal

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit type and material.

2.3 METAL WIREWAYS

A. Description: Sheet metal sized and shaped as indicated, NEMA Type 1, unless otherwise indicated.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Hinged type, Screw-cover type, Flanged-and-gasketed types as conditions warrant.

D. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers:
      a. Thomas & Betts Corporation.
      c. Wiremold Company (The); Electrical Sales Division.
      d. Or, Equal

2.5 BOXES, ENCLOSURES, AND CABINETS
A. Shall be of size and shape best suited for particular application, properly code sized for number of wires and conduits passing through or terminating therein, but in no case less than 4 inches square. Support boxes directly to structural members, framing or blocking by means of screws, anchors or bolts.

B. Outlet boxes shall be Appleton FS and FD Cast Aluminum, malleable iron, threaded type. Boxes shall be fitted with copper-free aluminum covers. Surface covers shall be used where exposed wiring is permissible.
   1. Outlet boxes in damp or outdoor locations shall be malleable iron with threaded hubs, fitted with gasket and cast cover.

C. Pull Boxes: Indoor pull boxes fabricated of code gauge steel, of size shown or as required, complete with screw covers, surface type in unfinished areas, primed, and painted. See drawings for additional requirements.
   1. Hoffman NEMA 1, ASE Series or equal.

D. Pull boxes used outdoors or in damp locations fabricated of code gauge steel with rain-tight welded seams, conduit hubs on top or sides, screw covers with neoprene or korpren gaskets. Hardware non-ferrous metal or hot-dipped galvanized. Boxes located on roof, entire boxes painted two coats of rust-inhibiting aluminum paint, Rustoleum or equal. Boxes located on building walls or free standing; finish powder paint color to match exterior building color.
   1. Hoffman, NEMA 3R, A Series or equal.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT with rain tight fittings.

B. Comply with the following outdoor applications, unless otherwise indicated:
   1. Rigid metal conduit (RMC)
   2. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.

C. Minimum Raceway Size: 3/4 inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

3.2 RACEWAYS & BOXES

A. Keep raceways at least 10 feet away from parallel runs of flues and steam or hot-water pipes. Mount horizontal raceway runs above water and steam piping.

B. Complete raceway placement before starting conductor Work.

C. Support raceways as specified in Section 260529 Hangers and Supports.

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
F. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main
      reinforcement. Where at right angles to reinforcement, place conduit close to slab
      support.
   2. Arrange raceways to cross building expansion joints at right angles with expansion
      fittings.
   3. Note that some building or local electrical codes may not permit nonmetallic tubing in
      fire-rated slabs in subparagraph below.
   4. Change from PVC to RMC, Type EPC-40-PVC, rigid steel conduit before rising above
      the floor.

G. No more than the equivalent of three 90-degree bends in any conduit run will be accepted
   except for communications conduits, for which only two 90-degree bends are allowed.

H. Threaded Conduit Joints, Exposed to Wet, Damp, or Outdoor Conditions: Apply listed
   compound to threads of raceway and fittings before making up joints. Follow compound
   manufacturer's written instructions.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating
   bushings to protect all conductor sizes, including conductors smaller than No. 4 AWG.

J. Raceway terminations at mechanical equipment shall terminate with a maximum length of 3-
   feet LFMC.

K. Provide pull lines in empty raceways. Use polypropylene or monofilament plastic line with
   not less than 200 pound tensile strength. Leave at least 12 inches of slack at each end of
   pull wire. Tag pull lines at each end indicating the location of the opposite.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and
   nonmetallic, rigid and flexible, as follows:
      1. Trade Size 1-1/4 inch and Smaller: Install raceways in maximum lengths of 50 feet.
      2. Trade Size 1-1/2 inch and Larger: Install raceways in maximum lengths of 75 feet.
      3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway
         unless Drawings show stricter requirements. Separate lengths with pull or junction
         boxes or terminations at distribution frames or cabinets where necessary to comply with
         these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them
   with listed sealing compound. For concealed raceways, install each fitting in a flush steel
   box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
   Install raceway sealing fittings at the following points:
      1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated
         spaces.
      2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RMC/IMC: Install in each run of aboveground conduit that is
   located where environmental temperature change may exceed 30 deg F, and that has
   straight-run length that exceeds 50 feet.
1. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Identify raceways and pull boxes per system in accordance with Section 26 05 53 Identification.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION
SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Section includes:
   1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
   2. Handholes and pull boxes.

1.2 RELATED SECTIONS

A. Section 260519 Conductors and Cables

B. Section 260553 Identification

1.3 DEFINITION

A. RMC: Rigid Metal Conduit.

B. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.

B. Product Data: For the following:
   1. Duct-bank materials, including separators and miscellaneous components.
   2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Accessories for manholes, handholes, pull boxes, and other utility structures.
   4. Warning tape.

C. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Reinforcement details.
   3. Frame and cover design and manhole frame support rings.
   4. Ladder details.
   5. Grounding details.
   6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
   7. Joint details.
D. Product Certificates: For concrete and steel used in precast concrete manholes, pull boxes and handholes, comply with ASTM C 858.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE


B. Comply with the current issue of the California Electrical Code.

C. Comply with the District Standards

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and pull boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the District's Representative.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to five percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT


B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Basis-of-Design Product: Carlon or comparable product by one of the following:
1. Cantex, Inc.
2. Allied Tube & Conduit; Atkore International.
3. JM Eagle; J-M Manufacturing Company, Inc.
4. DCX-CHOL Enterprises, Inc.; ELECSYS Division.
5. Electri-Flex Company.
6. IPEX Inc.
7. Lamson & Sessions; Carlon Electrical Products.
8. Or, Equal.

B. Duct Accessories:
   1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and retained to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
   2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification."

2.3 PRECAST CONCRETE HANDHOLES AND PULL BOXES

A. Manufacturers: provide products by one of the following:
   1. Jensen Precast
   2. Christy Concrete Products.
   5. Or, Equal.

B. Comply with ASTM C 858, SCTE 77. for design and manufacturing processes.
   2. Configuration: Units shall be designed for flush burial and have bottom, as indicated in the drawing details.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, "ELECTRIC." "TELEPHONE.", etc. as required for each service.
   6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   7. Handholes 16 inches wide by 30 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

E. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.

1. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.

2. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing stainless-steel bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.

3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

4. Cover Legend: Molded lettering, As indicated for each service.

5. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.

6. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

2.4 PRECAST MANHOLES

A. Manufacturers: provide products by one of the following:
   1. Jensen Precast
   2. Christy Concrete Products.
   5. Or equal.

B. Comply with ASTM C 858 with structural design loading as specified in "Underground Enclosure Application" Article, and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   a. Type and size shall match fittings to duct or conduit to be terminated.
   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: provide products by one of the following
   1. Jensen Precast
   2. Christy Concrete Products.
   3. Cretex Concrete Products West, Inc.; Riverton Division.
   5. Hubbell Power Systems; Lenoir City Division.
   8. NewBasis.
   12. Underground Devices, Inc.
   13. Or equal

B. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 (A 153M) and A 123 (A 123M).

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
   1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.
      a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
      b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
   2. Cover Legend: Cast in. Retained to suit system.
      a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
      b. Legend: "SIGNAL" for communications, data, and telephone duct systems.
3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
   a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387/C 387M, Type M, may be used.


E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
   1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
   1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
   1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt. 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

I. Cable Rack Assembly: Steel, hot-dip galvanized except insulators.
   1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
   2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

K. Fixed Manhole Ladders: Arranged for attachment to roof and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

L. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.
B. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 CORROSION PROTECTION

A. Aluminum shall not be installed in contact with earth or concrete.

B. RMC shall be wrapped with 10 mil tape or provided with PVC coating.

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-80 Type - PVC, in concrete-encased duct bank unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40 - PVC, in concrete-encased duct bank unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40, in concrete-encased duct bank unless otherwise indicated.


3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."
3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 60 inches, horizontally and 36 inches vertically, at other locations unless otherwise indicated. Manufacturer's listed maximum pulling tension may dictate increasing the radius if pull exceeds 250 feet.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 ft. from the end bell without reducing duct line slope and without forming a trap in the line.
   2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
   3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 ft. outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 ft. of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 3 feet between power and signal ducts when parallel.

7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.

8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDBOLES, AND PULL BOXES

A. Precast Concrete Handhole and Manhole Installation:
   1. Comply with ASTM C 891 unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
   1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
   2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

4. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDBOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level 6-inch-thick bed of No.2, ¾-inch crushed gravel road base material, compacted to same density as adjacent undisturbed earth.

C. Elevation: Set so cover surface will be flush with finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Retain arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

F. For enclosures installed in areas subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface
screeded to top of box cover frame.  Bottom of ring shall rest on 6-inch-thick bed of No.2, ¾-inch crushed gravel road base material compacted to 95%.

1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: Comply with the manufacturer's installation instructions to maintain listing for H20 vehicle loading.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION
SECTION 26 05 48
VIBRATION AND SEISMIC CONTROLS

PART 1 - GENERAL

1.1 SCOPE

A. Section includes:
   1. Channel support systems.
   2. Anchors

1.2 RELATED SECTIONS

A. Section 26 05 33 Raceway and Boxes
B. Section 26 05 29 Hangers and Supports
C. Section 26 22 00 Low Voltage Transformers

1.3 DEFINITIONS


1.4 PERFORMANCE REQUIREMENTS

A. Provide systems, units, equipment, and parts to meet or exceed current applicable requirements for seismic resistance specified by codes, regulations and authority having jurisdiction. Include all supports, anchors, braces and other restraining devices required.

B. Seismic bracing shall meet requirements of CBC Chapter 16A.

1.5 SUBMITTALS

A. Submit in accordance with of Section 01 33 23 Shop Drawings, Product Data and Samples.

B. Product Data: For the following:
   1. Seismic restraints and bracing systems.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Manufacturers:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Unistrut; Tyco International, Ltd.
   3. Hilti Inc.
   4. Or equal
B. General Requirements for Restraint Components: As noted in the Drawings.

2.2 FACTORY FINISHES

A. Finish: Galvanized steel

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before further placement of equipment, panels, boxes, conduits, etc.

C. Proceed only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways: Secure raceways to trapeze member with bolted 2 piece clamps.

B. Torque fittings, anchors and connections per manufacturer’s recommended values.

3.3 FIELD QUALITY CONTROL

A. Perform Tests and Inspections:
   1. Test at least 4 of each type and size of secured anchors and fasteners selected by District’s Representative.
   2. Test to 90 percent of rated proof load of device.
   3. If a device fails test, modify all mountings of same type and retest until satisfactory results are achieved.

END OF SECTION
SECTION 26 05 53
IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE

A. Section includes:
   1. Identification for raceways
   2. Identification of power and control cables
   3. Identification for conductors
   4. Warning labels and signs
   5. Instruction signs
   6. Equipment identification labels
   7. Miscellaneous identification products

1.2 RELATED SECTIONS

A. Division 26 Electrical
B. Division 28 Electronic Safety and Security

1.3 DEFINITIONS

A. ANSI: American National Standards Institute
B. CFR: Code of Federal Regulations
C. OSHA: Occupational Safety & Health Administration
D. NFPA: National Fire Protection Association

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For each electrical identification product indicated.

1.5 QUALITY ASSURANCE

D. Comply with ANSI Z535.4 for safety signs and labels.
1.6 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer’s wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and OSHA 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate Work of identifying devices with completion of covering and painting of surfaces where devices are to be applied and with location of access panels and doors.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Engraved laminated impact resistant acrylic tag engraved with white lettering on black background with capitalized 3/8 inch high lettering secured with 1 piece nylon tie.
   1. Legend: Indicate voltage and system or service type

2.2 POWER CABLE PHASE IDENTIFICATION MARKERS

A. Clear plastic over wrap-to-wrap 1-1/4 times minimum around cable. Label colored per color-coding with phase letter printed 1 inch high. Apply to each cable.

B. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.3 WIRE MARKER MATERIALS

A. Slip-on wire markers: PVC wire marker with permanent machine printed or embossed lettering.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70.

B. Provide plastic laminated impact resistant acrylic plate, 2 layer, 3/16 inch minimum thickness, machine engraved with capitalized red lettering, on white background. Lettering 2 inches high.

C. Warning label and sign shall include, but are not limited to, the following legends:
   1. Workspace Clearance Warning for 250 volts & less: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
   2. On all motors: “CAUTION. AUTOMATIC EQUIPMENT. MAY START AT ANY TIME.”

2.5 SWITCH AND RECEPTACLE LABELS

A. Provide clear color base dymo labels on all lighting switches and convenience and special purpose receptacles to show panel and circuit number to which the device is connected.

2.6 EQUIPMENT IDENTIFICATION LABELS
A. Provide rigid plastic laminated impact resistant acrylic plate, 2 layer, with 3/16 inch minimum thickness, machine engraved with 3/8 inch high capitalized white lettering, on black background.
   1. Provide nameplates on the following:
      a. Panels
      b. Motor starters
      c. Disconnect switches
      d. Associated electrical devices
      e. Pull boxes indicating feeder designation
   2. For remote devices such as disconnect switches, etc. and all panels indicate the source of power.
   3. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.7 CABLE TIES

A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, 1 piece, self locking, Type 6/6 nylon.
   2. Tensile Strength at 73 degrees Fahrenheit, 12,000 psi (82.7 MPa).
   3. Temperature Range: Minus 40 to plus 185 degrees Fahrenheit.

PART 3 - EXECUTION

3.1 IDENTIFICATION MATERIALS

A. Verify identity of each item before applying identification products.

B. Location: Apply identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Attach signs and acrylic labels with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of 2-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
3.2 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and
junction boxes, manholes, and handholes, use color-coding conductor tape to identify the
phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors
listed below for ungrounded service, feeder, and branch-circuit conductors.
   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if
      authority having jurisdiction permits.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral: White.
      5) Ground: Green.
   c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a
      minimum distance of 6 inches (150 mm) from terminal points and in boxes where
      splices or taps are made. Apply last 2 turns of tape with no tension to prevent
      possible unwinding. Locate bands to avoid obscuring factory cable markings.

B. Warning Labels for Indoor Cabinets, Boxes, Motors and Enclosures for Power and Lighting:
Mechanically fastened warning labels.

1. Identify system voltage with black letters on an orange background.
2. Apply to exterior of door, cover, or other access.
3. For equipment with multiple power or control sources, apply to door or cover of
   equipment including, but not limited to, the following:
   a. Controls with external control power connections.

C. Equipment Identification Labels: On each unit of equipment, apply unique designation label
that is consistent with wiring diagrams, schedules, and the Operation and Maintenance
Manual. Apply labels to disconnect switches and protection equipment, central or master
units, control panels, control stations, terminal cabinets, and racks of each system. Systems
include power, lighting, control, communication, signal, monitoring, and alarm systems
unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or
      NRTL rating of the enclosure.

2. Equipment to Be Labeled:
   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard
      manufacturer. Panelboard identification shall be engraved, laminated acrylic or
      melamine label.
   b. Distribution Panels
   c. Enclosures and electrical cabinets.
   d. Contactors.
e. Variable Frequency Drives.
f. Motors
g. Monitoring and control equipment.

END OF SECTION
SECTION 26 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes computer-based, fault-current (short-circuit study) protective device evaluation study, coordination of protection devices and Arc Flash Risk Assessment. Protective devices shall be set based on results of the protective device coordination study. The final study will be generated based on the final electrical equipment submittals and the final pulled conductor lengths for all feeders.

B. Based on the findings of the final report, the electrical consultant/contractor shall adjust all required protective device settings based on the results of the protective device coordination and/or Arc Flash Risk Assessment.

C. The electrical consultant/contractor shall also install Arc Flash Risk (Incident Energy, Available Fault Current) labels on all switchboards and panelboards provided as part of the Arc Flash Risk Assessment.

1.2 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.

B. Product Data: For computer software program to be used for studies.

C. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

D. Qualification Data: For coordination-study specialist.

E. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets in MS Excel format, XLS.

2. Study and Equipment Evaluation Reports shall indicate worst-case scenario conditions and associated results.

3. Coordination-Study Report including computer generated Time-current Characteristic Curves (TCC).


1.3 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Software QA program shall comply with ISO 9000 with accredited certification agency such as UL. Manual calculations are not acceptable.
B. Coordination-Study Specialist Qualifications: A manufacturer or independent entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
   2. REFERENCES
   3. Institute of Electrical and Electronics Engineers (IEEE):

C. IEEE 242 for short-circuits currents and coordination time intervals.
   - IEEE 399 for general study procedures.
   - IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
   - IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
   - IEEE 1584 – Guide for Performing Arc Flash Hazard Calculations

D. American National Standard Institute (ANSI):
   - ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
   - ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
   - ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
   - ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

E. National Fire and Protection Association (NFPA):
   - NFPA 70 – California Electrical Code

F. NFPA 70E – Standard for Electrical Safety in the Workplace

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
   1. ETAP.
   2. SKM Systems Analysis, Inc.
   3. Easy Power.
   4. Or, Equal.
2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current-coordination plots.

1. Optional Features:
   a. Arcing faults.
   b. Simultaneous faults.
   c. Explicit negative sequence.
   d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Maximum fault contribution or impedance of utility service entrance.

3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
   a. Circuit-breaker and fuse-current ratings and types.
   b. Relays and associated power and current transformer ratings and ratios.
   c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
   d. Generator kilovolt amperes, size, voltage, and source impedance.
   e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
   f. Busway ampacity and impedance.
g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Generator thermal-damage curve.
   e. Ratings, types, and settings of utility company's overcurrent protective devices.
   f. Special overcurrent protective device settings or types stipulated by utility company.
   g. Time-current-characteristic curves of devices indicated to be coordinated.
   h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
   i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
   j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Switchgear and switchboard bus.
   2. Motor-control center.
   3. Distribution panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current at each location:
   1. Electric utility's supply termination point
   2. Incoming switchgear
   3. Unit substation primary and secondary terminals
   4. Low voltage switchgear
   5. Motor control centers
   6. Standby generators and automatic transfer switches
   7. Branch circuit panelboards
   8. Other significant locations throughout the system
D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:
   a. IEEE C57.96.


3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

2. One-line diagram of the system being evaluated with available fault at each bus

3. Typical calculation examples.

F. Equipment Evaluation Report:

1. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

2. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY


1. Calculate the maximum and minimum 1/2-cycle short circuit currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH RISK ASSESSMENT

A. Perform Arc Flash analysis according to the IEEE 1584 guidelines and equations presented in NFPA 70E-2015, Annex D. Analysis shall be performed in conjunction with Short Circuit analysis and Protective Device Time-Current Coordination analysis.

B. Incident Energy and Flash protection boundary shall be calculated at all location where energized work could be performed such as switchboards, switchgear, motor control centers, panel boards, busway and tiebreakers.

C. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

D. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

E. Multiple system configurations and operating conditions shall be considered and greatest incident energy must be selected for each equipment location.

1. Provide a tabular view report of all configurations and operating conditions used.

2. Provide calculation methods and assumptions including any adjustments used when considering resistance and impedance tolerances.
F. When applicable, Utility Minimum and Maximum contributions should be considered. Calculations shall also take into consideration the maximum let through fault current of the utility transformer, the parallel operation of local generators with utility source as well as any stand-by generators.

G. Include scenarios when the main source protective devices are or are not adequately isolated from the bus and may fail to operate or be capable of de-energizing the arc fault before it escalates into a line-side arc fault.

H. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

I. The Arc flash analysis shall include all 480-volt locations and significant locations in 240 volt and 208 volt systems.

J. Arc Flash Risk Assessment report:
   1. Arc Flash reports shall compare results from the various arc flash hazard assessments and be capable of filtering the “worst case” Arc Flash analysis results coming from different scenarios in a single table report.
   2. Provide a report in a tabulated format that displays the sequence of operation of protective devices during an arc fault.
   3. Recommendations for arc flash energy reduction including the use of arc reduction maintenance switches, current limiting fuses, replacement of overcurrent protective devices and/or trip units, or replacement of equipment with arc resistant or preventative designs.

K. Arc Flash Warning Labels:
   1. Consultant shall provide a Durable 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
   2. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the Company and after any system changes, upgrades or modifications have been incorporated into the system.
   3. The label shall include the following information, at a minimum:
      a. Location
      b. Nominal voltage
      c. Flash protection boundary
      d. Available Fault Current
      e. Incident energy
      f. Working distance
      g. Engineering study number, revision number and issue date
4. Arc Flash warning label sample is shown below:

Arc Flash and Shock Hazard Present
Appropriate PPE Required

Arc Flash Boundary 5.7 ft
Incident Energy in cal/cm² 5.7
Working Distance 24 in

Minimum PPE Requirements
FR long-sleeve shirt (minimum arc rating of 4), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8)

Shock Hazard Exposure 480 VAC
Insulating Gloves Class 00
Shock Hazard when covers removed

Limited Approach Boundary 3.5 ft
Restricted Approach Boundary 1.0 ft

5. Labels shall be machine printed, with no field markings.

6. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
   a. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided for each section
   b. For each motor control center, one arc flash label shall be provided for each section
   c. For each low voltage switchboard, one arc flash label shall be provided for each section
   d. For each switchgear, one flash label shall be provided for each section.
   e. For medium voltage switches one arc flash label shall be provided

7. Labels shall be installed by the engineering services division of the Company under the Startup and Acceptance Testing contract portion.

END OF SECTION
SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS
A. The General Conditions, Supplementary Conditions and Division 01 are fully applicable to this Section, as if repeated herein.

1.2. RELATED WORK SPECIFIED ELSEWHERE
A. Division 01, Section 01 91 13, General Commissioning Requirements
B. All Division 26 Sections.

1.3. REFERENCES
A. USGBC:
   1. LEED v4.0 Reference Guide for Building Design and Construction:
      a. Energy and Atmosphere Prerequisite: Fundamental Commissioning and Verification.

B. California Energy Commission:
   1. Title 24, Part 6, 2016, Building Energy Efficiency Standards, Section 10-103 and Section 120.8-Building Commissioning

C. ASHRAE:
   1. ASHRAE Guideline 0-2013: The Commissioning Process

D. NETA:
   1. ANSI/NETA 2013 Standard for Acceptance Testing Specifications

E. The Collaborative for High Performance Schools:

1.4. DEFINITIONS
A. Basis of Design (BOD): The documentation of design criteria and assumptions for systems, components, and methods chosen to meet the Owner’s Project Requirements and applicable regulatory requirements, standards, and guidelines. The document includes narrative descriptions of the systems to be commissioned. The BOD is prepared by the Design Professionals.

B. Building Automation System (BAS): The automated building system providing control and user interaction with select building systems, such as the HVAC, domestic hot water and lighting systems. Also, often referred to as building management system (BMS), energy management system (EMS), or an energy management and control system (EMCS).
C. Commissioning (Cx): A quality-focused process to verify and document that building systems are installed and perform as intended per the OPR, BOD and design documents.

D. Commissioning Authority (CxA): An independent agent hired directly by the Owner and not otherwise associated with the Design Professionals or the General Contractor. The CxA is the authority on commissioning results and other commissioning program elements completion, and assists the General Contractor with coordinating commissioning activities and witnesses the activities on behalf of the Owner.

E. Commissioning Issue: A condition that affects, prevents or inhibits commissioning, and must be resolved to complete the commissioning process.

F. Commissioning Issues & Recommendations Log (Cx Log): A log maintained by the CxA listing and describing all Cx issues documented during the commissioning process, including providing the status, recommended action, contractor updates and resolution, and associated dates. All Cx issues require action, correction and closure.

G. Commissioning Report (Cx Report): The final report issued at the conclusion of the commissioning process. The report will include an executive summary abbreviating the outcome of the commissioning process and identifying all outstanding issues. The report also contains all commissioning documentation collected throughout all phases of the project.

H. Commissioning Plan (Cx Plan): A document that outlines the organization, coordination, and requirements of the commissioning process in more detail and contains project specific commissioning forms.

I. General Contractor (GC): The contractor directly contracted to the Owner with overall responsibility for the project and all commissioning activities described herein.

J. Commissioning Coordinator (CxC): Individual within the GC firm who plans, schedules, directs and coordinates all the Trade Subcontractor's commissioning activities, and serves as the CxA's single point of contact for all administrative, documentation and coordination functions.

K. Deferred Testing: Testing performed at a later time, due to partial occupancy, equipment, load, seasonal requirements, design or other site conditions that disallow the test from being performed prior to substantial completion.

L. Deficiency: A condition in the installation, function or performance of a component, equipment or system that is not in compliance with the contract documents and design. A deficiency will be considered a Cx issue and documented on the Cx Log.

M. Design Professional (DP): Architects, engineers and other consultants involved in the design of the project.

N. Functional Performance Test (FPT): A test of the dynamic function, operation and control of the equipment and systems to verify system performance to the fullest extent. Systems are tested under various operating modes and control sequences including failure modes. The FPTs are performed using manual (direct observation) or monitoring methods. The FPTs can include sequence of operation tests, performance tests, verification tests, integrated systems tests, and trend analysis.

O. Installation Verification (IV): Field verification and documentation of proper installation of system equipment, assemblies and components, per design documents and manufacturer requirements. The IV process is typically complete when systems are ready for startup or
operation. IV is organized and documented under the System Readiness Checklist (SRC) forms.

P. Monitoring: The recording of parameters (time of day, power, current, voltage, status, illuminance, etc.) of equipment operation, which shall be completed using data-loggers or the trending capabilities of BAS or control systems.

Q. Owner’s Project Requirements (OPR): A document describing the operational and functional requirements of a project, the expectations of how the facility will be used and operated, and the equipment and system expectations and requirements, as defined by the Owner. This document provides an explanation of the ideas, concepts, goals, success criteria, and supporting information for the project.

R. Percent Sampling: Witnessing the startup, checkout or testing of a selected fraction of the total number of identical or near-identical pieces of equipment or systems.

S. Pre-Functional Checks and Tests (PFCT): These are various checks and tests performed on a piece of equipment or system before, during, or after the initial startup and operation, but prior to the FPT phase. They are performed to confirm the system equipment and individual components were installed correctly, are working properly and meeting applicable performance requirements and specifications. For electrical service and distribution systems, examples include applicable visual and mechanical inspections and electrical tests per ANSI/NETA performed prior to system FPTs. For lighting systems, examples include: lighting control system point-to-point checks, sensor calibrations or accuracy checks, individual sensor and switch tests, controls programming checks, etc. They are all organized and documented under the SRC forms and are to be completed prior to FPTs.

T. Startup: Initial starting or activating of equipment usually performed by the Trade Subcontractor or the Manufacturer’s authorized representative.

U. Systems Manual: A manual that provides the operating staff the information needed to understand and optimally operate the commissioned systems. It expands upon the scope of traditional operating and maintenance documents and is compiled of multiple documents such as the final BOD, single line diagrams, and as-built controls drawings and sequences of operation.

V. System Readiness Checklist (SRC): A construction checklist, typically one or two pages, listing the necessary commissioning tasks and required documentation to verify a system is ready for FPTs, or system operation if no FPTs are performed. The tasks covered in the SRC include IV, Startup and PFCT, and the Trade Subcontractor completed forms for these tasks are attached to the specific SRC. The SRC must be completed and signed by the GC prior to conducting the FPTs.

W. Trade Subcontractor: Typically a subcontractor to the GC who provides and installs specific building components and systems and/or provides certain services.

X. Trending: Monitoring using the BAS or a control system, to aid in functional testing and to verify system operation and performance under actual operating conditions.

Y. Warranty Phase: The phase of the project immediately after the initiation of the building equipment warranty which spans the entire length of the project warranty.

1.5. DESCRIPTION OF WORK

A. Systems and equipment to be commissioned:
1. Lighting and controls
2. Electrical systems, including service and distribution (transformers and main switchboard)
3. Electric, gas and water metering and sub-metering and receptacle load control – if applicable
4. Solar photovoltaic systems including inverters

B. Process equipment are not included in the commissioning scope of work

C. The work includes the completion and documentation of formal commissioning procedures by the GC and Trade Subcontractors.
   1. The GC and Trade Subcontractors shall provide the quality control for the installation, startup, checkout and testing of the systems. The commissioning process provides independent review throughout the process and qualitative functional performance testing in order to formally observe and document the quality control efforts are completed.
   2. Refer to Section 01 91 13, General Commissioning Requirements for summary description of the general commissioning process and requirements.
   3. The Trade Subcontractors and the factory authorized service representatives shall be responsible for participation in the commissioning process as outlined in this specification and Section 01 91 13 General Commissioning Requirements.

1.6. COMMISSIONING PROCESS

A. Submittal Reviews by the CxA
   1. The CxA will review pertinent Trade Subcontractor submittals for the appropriate systems in the commissioning scope, concurrently with the Design Professionals and will provide review comments to the Design Professionals.
   2. The GC shall provide a submittal log to the CxA for referencing the requested submittals to be reviewed by the CxA (for which the GC shall issue to the CxA concurrently with the submission to the Design Professionals). Alternatively, the GC shall include the CxA on the distribution of all Trade Subcontractor submittals issued to the Design Professionals, for systems applicable to this specification.
   3. The GC shall issue the requested submittals to the CxA for review at the same time they issue the submittals to the Design Professionals.
   4. The CxA will also use the information from the submittals to develop commissioning forms and test procedures.

B. Cx Plan and Form Development
   1. The CxA prepares a Preliminary Cx Plan either during the project final design phase or early construction phase. The Cx Plan provides guidance in the execution of the commissioning process during construction and will contain the project specific commissioning forms.
   2. Commissioning during construction begins with a kickoff meeting conducted by the CxA where the CxA reviews the commissioning process and responsibilities with the appropriate team members. The CxA presents the Preliminary Cx Plan and discusses the project specific requirements.
   3. The CxA develops the SRC forms, which list the commissioning tasks and the associated IV, Startup, and PFCT documentation required for each system and equipment to be commissioned.
4. The CxA provides the SRC forms to the GC and Trade Subcontractors for review and comment.

5. The CxC shall submit to the CxA, for review and approval, the representative blank IV, Startup, and PFCT forms and plans for completing all IV, Startup, and PFCT tasks, prior to conducting any of these tasks.
   a. IV forms are to provide field verification and documentation of proper installation of system equipment, assemblies and components, typically completed prior to formal Startup. Where appropriate and approved by the CxA, these forms may be combined with the Startup or PFCT forms.
      1) The IV forms are a combination of Trade Subcontractor provided forms (which may include any applicable design drawings, floor plans, details, or single line diagrams that will be field verified) and the applicable equipment IV (pre-startup) checklists contained in the Manufacturer’s installation manuals.
      2) The Trade Subcontractors are to verify equipment installation per the Manufacturer’s guidelines and requirements, and thus are encouraged to use and complete any applicable equipment IV checklists contained in the Manufacturer’s installation manuals, in addition to any IV forms used by the Trade Subcontractors to verify system installation per design.
   b. Startup forms consist of Manufacturer and/or Trade Subcontractor provided forms and plans used to document the completion of formal startup procedures and associated checks and verifications during the startup and initial operation. Where applicable, these forms shall include checks of the equipment internal / factory provided controls including sensors and control devices.
   c. PFCT forms and plans are Trade Subcontractor provided forms and plans used to document the completion and results for the various checks and tests performed before, during, or after startup.
   d. The CxA reviews the blank IV, Startup and PFCT forms and plans, and will issue any comments, which may include additions or changes to be made to the forms and plans, and/or supplemental forms may be issued by the CxA, where appropriate, to improve the forms and commissioning process.

6. The CxA will develop FPT procedures and forms, and provide the draft forms to the GC and Trade Subcontractors for review and comment.

7. The CxA will update and finalize the Cx Plan with equipment specific blank SRC, IV, PFCT and FPT forms.

C. System Readiness (Pre-Functional) Activities
   1. Meetings will be conducted throughout construction with commissioning team members, as required, to plan, coordinate, and schedule commissioning activities, review documentation, and resolve Cx issues.
   2. The Trade Subcontractors shall perform the IV, Startup and PFCT tasks for all systems and equipment (no sampling allowed), unless the contract or design documents allow for sampling of the pre-functional tests.
      a. In general, the GC and Trade Subcontractors should complete IV prior to Startup, but where appropriate and approved by the CxA, they can combine IV and Startup into one activity (and Startup is not performed if there are deficiencies identified from the IV).
3. The Trade Subcontractors and the CxC shall document completion of the IV, Startup and PFCT tasks on the IV, Startup, PFCT and SRC forms, and shall complete the SRC forms and attach the completed IV, Startup, and PFCT forms to the SRCs forms.
   a. The intent of the SRC forms is for the GC and Trade Subcontractors to certify that the electrical systems, controls and instrumentation, equipment and assemblies have been installed, started, calibrated and are operating per the contract and design documents.

4. The CxA will review the completed IV, Startup, PFCT and SRC forms. The CxA will also perform various field observations and reviews, and witness a sample of the Startup and PFCT activities (some PFCT witnessing may be performed as back-checks after PFCT tasks are completed).
   a. The Trade Subcontractor shall resolve any IV and PFCT results deemed unacceptable by the CxA. And the Trade Subcontractor shall execute a new sample of the PFCT to be witnessed by the CxA. The CxA shall deem the PFCT acceptable after resolution of all issues and any witnessed sampling results in no issues.

5. The CxC shall submit all completed SRC forms to the CxA for review prior to conducting the FPTs. The CxA shall deem the SRCs acceptable after all SRC forms and supporting IV, Startup and PFCT forms are complete and any issues have been addressed.

D. Functional Performance Testing

1. FPTs are to test the dynamic function, performance and control of the equipment and systems under various modes of operation. These tests verify the correct implementation of the sequences of operation and the system performance meets the design criteria. The FPTs are performed using manual (direct observation) or monitoring methods. FPTs include the following types of tests, where applicable:
   a. Sequence of Operation Tests.
      1) Sequence of operation tests are witnessed by the CxA for each unique sequence of operation but may not necessarily be repeated across identical systems or spaces, if the contractor has verified the same programmed sequence of operation code (as tested) has been programmed across multiple identical systems or spaces, based sample verification tests witnessed by the CxA (see below).

   b. Verification Tests.
      1) Verification tests are often less detailed tests than the sequence of operation tests and are typically witnessed by the CxA at a higher sample rate. Examples of verification tests include:
         a) verifying the programmed sequence of operation code is the same as the as-tested code per the sequence of operation tests,
         b) verifying the alarm points are configured per the sequence of operation tests (without having to repeat the actual sequence tests),
         c) reviewing and confirming control point displays on system graphics and required setpoints,
         d) testing certain critical or important sequences with a higher sample rate across identical systems or spaces, beyond the individual sequence of operation tests.

   c. Performance Tests.
1) Performance tests are to be performed after the sequence of operation and
verifications tests, and are focused on testing and verifying performance.
Performance tests are typically witnessed by the CxA at a lower sample rate.
Examples include:
   a) measuring and testing indoor light level,
   b) testing the performance of an emergency power generator using a load bank,
      to verify the power output for a prescribed startup condition and prescribed
      operating duration and conditions.

d. Integrated Systems Tests.
    1) Integrated systems tests verify the operation and performance of multiple systems
       together operating in a coordinated, stable and efficient manner. An example is a
       whole building emergency power integrated systems tests, to test the combined
       operation of the transfer switches and emergency power generators, as well as the
       electrical service and distribution systems, lighting, etc., and other building
       systems during an actual loss of normal utility power and then upon return of
       normal power.

e. Trend Analysis

2. The CxA will develop FPT forms that contain:
   a. Specific step-by-step procedures to execute the test in a clear, sequential and
      repeatable format, including any control system point value or setpoint overrides
      required to simulate a test condition or sequence mode.
   b. The expected system response and acceptance criteria of proper performance with a
      Yes/No check box to allow for clearly marking whether or not proper performance of
      each part of the test was achieved.
   c. A section for recording actual system response, notes and comments.

3. Once the SRC forms are complete, the Trade Subcontractors shall execute the FPTs, with
   the FPTs witnessed by the CxA.
   a. The GC and Trade Subcontractors are responsible for ensuring all systems are
      installed, operating and performing per the requirements of the contract and design
      documents, and are ready for the FPTs.
   b. The Trade Subcontractors shall determine what level of pre-testing is appropriate in
      order to prepare for the CxA witnessed FPTs.
   c. The CxA recommends the Trade Sub-Contractors complete the Title 24 acceptance
      testing and forms (see paragraph f below) as part of the contractor's pre-testing and
      readiness for the CxA witnessed FPTs.
   d. A percent sampling approach shall be used for executing the FPTs of identical
      systems and equipment. The approximate system sampling rates for the manual
      (direct observation) FPTs are defined in Part 3 of this specification and/or in the CxA
      Plan.
   e. The acceptance criteria for the FPT sampling shall be zero, meaning, any FPTs that
      do not pass shall require the Trade Subcontractor to resolve the issue for all applicable
      systems and equipment (even those specifically not in the original sample) and new
      sample rates selected for a re-test executed by the Trade Subcontractor and
      witnessed by the CxA. The CxA shall deem the FPTs acceptable after all FPTs,
      including re-tests, have passed and resolution of all issues completed.
f. The CxA will document the results of all FPTs on the associated FPT forms created by the CxA, unless indicated otherwise on the FPTs, and excluding completion of the Title 24 Certificate of Acceptance forms.

1) Completion of the Title 24 Certificate of Acceptance forms (contained in Appendix A of the Title 24, Part 6 Compliance Manual) is a contractor responsibility, not the CxA responsibility.

2) The responsible Division 22, 23, 25 and 26 Trade Subcontractors are also responsible for providing qualified and certified "Field Technicians" (per Title 24, Part 6 requirements) to perform and document the results of the acceptance tests on the applicable Title 24, Part 6 Certificate of Acceptance forms.

4. The Cx Plan will define any required seasonal or deferred testing.

E. Cx Issues and Recommendations

1. Throughout the process, the CxA records Cx issues and recommendations on the Cx Log and distributes the Cx List to the team. The GC and Trade Subcontractors shall correct Cx issues and recheck or retest the system(s) without delay at no additional cost to the Owner. The CxA will verify the completion of the issues and recommendations, and make all amendments to the Cx Log.

F. Training Verification and Final Documentation

1. The GC shall submit a comprehensive Training Plan (with specific training agendas provided by the Trade Subcontractors) for review by the Design Professionals, CxA and Owner, prior to conducting any training. The Training Plan shall meet the specific requirements in the contract documents and specifications for each applicable system to be commissioned and the LEED Enhanced Commissioning requirements, and may include both operations and maintenance (O&M) staff training and building occupant training. The GC shall coordinate with the Owner and/or Owner's Representatives, as needed, regarding any specific requirements for occupant training.

2. The CxA will verify completion of the training by witnessing some training sessions and receiving a copy of all training class sign-in sheets and any training materials / handouts, to be provided by the CxC or Trade Subcontractors.

3. The CxA will develop the Systems Manual (per the LEED requirements), including the current facility requirements, a preventative information and an ongoing Cx plan, with assistance from the GC and Trade Subcontractors.

4. The CxA will complete the Commissioning Report and all associated documentation for the Owner with assistance from the GC and Trade Subcontractors.

G. Post-Occupancy Warranty Phase Commissioning

1. The CxA will report any identified operational or performance issues (identified by the building O&M staff or warranty phase Cx activities) to the CxC via a Warranty Phase Cx Log for resolution by the GC and Trade Subcontractors during or prior to the end of the warranty period.

2. The Trade Subcontractors shall execute any defined seasonal or deferred FPTs, witnessed by the CxA.

3. The CxA may review and analyze trend data during the Warranty Phase and will report any identified issues and recommendations for system improvements from the trend analysis.
4. No later than either 10 months after substation completion or two months prior to the expiration of the first 12-month warranty period of building occupancy, the CxA will return to the facility to interview facility O&M staff, walk the facility and review systems operation and trend data where applicable. Key representatives from the GC and Trade Subcontractors shall attend a site walk-through and meeting, as determined by the CxA.

1.7. COMMISSIONING TEAM

A. The Commissioning Team is responsible for performing the process and achieving successful commissioning results. The Commissioning Team is comprised of the following:

1. Owner and Owner’s Representatives
2. Commissioning Authority (CxA).
3. Design Professionals
4. General Contractor (GC)
5. GC’s Commissioning Coordinator (CxC)
6. Trade Subcontractors responsible for systems covered in this section include:
   a. Electrical Contractor
   b. Lighting Controls Contractor or Manufacturer’s Representative
   c. Receptacle Load Controls Contractor or Manufacturer’s Representative
   d. Energy & Water Metering System Specialist or Manufacturer’s Representative
   e. Third-party Electrical Systems Testing Agency (if applicable)
   f. BAS Contractor (if applicable)
7. Manufacturer Representatives supplying equipment, materials, components and controls for the systems to be commissioned.

1.8. RESPONSIBILITIES

A. General.

1. The Commissioning Team and all others involved in the commissioning process shall follow the Commissioning Plan, attend the commissioning kickoff meeting, and attend additional commissioning meetings as necessary.

B. Commissioning Authority (CxA)

1. See Section 01 91 13, General Commissioning Requirements.

C. General Contractor:

1. See Section 01 91 13, General Commissioning Requirements.

D. Trade Subcontractors – General Requirements:

1. Provide and submit for CxA review, the representative blank forms and plans for completing all IV, Startup, and PFCT tasks, including manufacturer’s installation checks and startup procedures. Electronic files are acceptable.

2. Provide any equipment and construction submittals and shop drawings, including detailed sequences of operation, and any other requested contract documentation for systems to be commissioned, as requested by the CxA. Electronic files are acceptable.
3. Attend commissioning meetings as directed by the CxA and GC's CxC to facilitate the commissioning process.

4. Assign personnel with expertise and authority to act on behalf of the Trade Subcontractor and schedule them to participate in and perform assigned commissioning tasks.

5. Ensure that any required manufacturer factory tests are performed and provide the factory test data and results where required.

   a. Perform IV, Startup and PFCT tasks for all systems and equipment (no sampling), unless the contract or design documents allow for sampling of these tasks.
   b. Complete all IV, Startup and PFCT documentation clearly and legibly.
   c. Submit all completed IV, Startup and PFCT forms to the CxC and CxA, as part of completing the SRC forms, for review by the CxA.

7. Provide a schedule and access for the CxA to witness any equipment Startup and PFCT tasks. Notify the CxC and CxA at least 10 days in advance of Startup and PFCT tasks.

8. Ensure that any required manufacturer's representative field tests and on-site IV, startup and checkout of selected equipment are performed per the contract documents. Provide completed manufacturer documentation and commissioning forms for these activities to the CxC.

9. Address applicable Cx issues promptly. All IV, Startup and PFCT issues must be resolved before the FPTs can proceed.

10. Assist the CxA in preparing the FPT procedures, clarifying the operation and control of commissioned equipment where the specifications, control drawings or equipment documentation are not sufficient for writing detailed testing procedures.

11. Review the FPT procedures to ensure feasibility, safety and equipment protection, and provide necessary written alarm limits, setpoint changes and overrides to be used during the tests.

12. Setup any additional control system software points, global commands, overrides of any sensor values or relays, and overrides of any setpoints or schedules, to simulate certain conditions and operating modes, in order to conduct the FPTs.

13. Perform the FPTs, with the FPTs witnessed by the CxA. Provide at least 10 days advance notice to the CxC and CxA for scheduling the FPTs.

14. The Division 26 Trade Subcontractor is responsible for providing qualified and certified "Field Technicians" (per Title 24, Part 6 requirements, where applicable) to perform and document the results of the acceptance procedures (Acceptance Tests) on Certificate of Acceptance forms per Title 24, Part 6.
   a. The GC or the responsible Trade Subcontractor shall be the designated "Responsible Person" per Title 24, Part 6, for certification of the acceptance testing/verification on the Certificate of Acceptance forms (contained in Appendix A of the Title 24, Part 6 Compliance Manual).

15. Setup any Lighting Control System, Power Monitoring or Energy and Water Metering & Sub-metering System, or BAS trends and provide all requested Trend data for the FPTs and post-occupancy warranty phase commissioning review to the CxA.
   a. As an Owner approved alternative, the Trade Subcontractors may provide the CxA remote access to these systems, with the Owner's permission, which will allow the CxA to easily and directly download the trend data files
16. Prepare a training agenda for each training class for the equipment and systems to be commissioned.

17. Coordinate with the GC and Owner to schedule and plan training. Execute training of Owner’s personnel per approved training agenda and schedule. Provide copies of training class sign-in sheets and materials / handouts.

18. Prepare O&M Manuals according to the Contract Documents.

19. Assist the CxA in developing the Systems Manual, including providing as-built drawings, controls sequences, setpoints, single-line diagrams, etc., necessary for the Systems Manual.

E. Trade Subcontractors – Specific Electrical System Requirements

1. In addition to the general Trade Subcontractor responsibilities outlined above, the Electrical Trade Subcontractor responsibilities during commissioning shall include, but are not limited to:

   a. Provide approved submittals, including shop drawings, control drawings, points list and detailed sequences of operation, meter lists and riser diagrams, etc., for each piece of equipment and system to be commissioned. The system sequence of operation shall fully describe their equipment components and functionality, including setpoints, failure modes and alarm functions. The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings. Electronic files are acceptable.

   b. Provide a list of any test metering and sensors to be used for sensor and device calibration purposes. All test meter and sensors shall have been calibrated within a year and have calibration documentation.

   c. Submit the Electrical Service & Distribution Systems IV and PFCT Plan with blank forms to be conducted by the Trade Subcontractors, for the applicable systems in the commissioning scope, for review by the CxA, at least 4 weeks in advance of conducting any IV. The Plan shall include the following items:

      1) An outline of the applicable ANSI/NETA visual and mechanical inspections and electrical tests to be conducted for each system / equipment type, following the NETA Standard, where required per design documents;

      2) An outline of the other applicable IV, PFCT and Startup tasks to be conducted for each system / equipment type, where the ANSI/NETA Standard is not required per contract documents or where other tasks will be performed in addition to those defined in the ANSI/NETA Standard.

      3) The representative blank forms to be used for all IV, Startup and PFCT tasks (including those following the ANSI/NETA Standard), as described above, where applicable);

      4) Third-party Testing Agency Qualifications (if a Third-party Testing Agency is required per the contract documents).

   d. Submit an Electric Meter IV and PFCT Plan with blank forms, for review by the CxA, at least 4 weeks in advance of conducting any IV. The Plan shall include the following items:

      1) An outline of the electric power meter IV per design and manufacturer requirements.
2) An outline of any electric meter pre-functional tests (e.g., CT ratio tests, meter primary or secondary injection tests or tests to compare meter readings to a calibrated hand-held device), required per specifications.

3) An outline of any electric meter pre-functional checks (e.g., meter programming checks, meter alarm configurations, etc.).

4) The representative blank IV and PFCT forms to be used.

e. Submit an Energy and Water Metering & Sub-metering System IV and PFCT Plan with blank forms, for the Electric, Gas and Water Metering System that records and monitors all meters, stores and presents the data including graphical user interface and dashboards, per the design. The IV and PFCT Plan for the electric meters is covered in the paragraph above. The Plan shall outline the following items:

1) system network communication and meter point-to-point checks,

2) software / virtual point checks including the calculations (for example end-use sub-total and building total consumption / data calculations),

3) graphical display and dashboard checks,

4) meter alarm reporting checks,

5) trend log configuration checks,

6) and the representative forms to be used for these checks.

f. Prior to conducting the CxA witnessed FPTs, place the systems and controls into the operating modes intended for testing. Check all control system alarms and interlocks with other systems during each mode of operation prior to functional testing. Ensure all systems are operating and performing per the requirements of the contract and design documents, and have been pre-tested per the FPTs, and are ready for the CxA witnessed FPTs.

1) The Trade Subcontractors shall determine the appropriate level of pre-testing, to prepare for the CxA witnessed FPTs.

F. Trade Subcontractors – Specific Lighting Systems, Lighting Controls and Receptacle Load Control Requirements

1. In addition to the general and specific Trade Subcontractor responsibilities outlined above, the Electrical Trade Subcontractor and/or the applicable Controls Manufacturer’s Representatives (for Lighting Controls and Receptacle Load Controls Systems) responsibilities during commissioning shall include, but are not limited to:

a. Provide approved submittals, prior to any controls construction activity, including shop drawings, control drawings, points list and detailed sequences of operation for each piece of equipment and system. The system sequence of operation shall fully describe their equipment components and functionality, including setpoints, failure modes and alarm functions. The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings. Electronic files are acceptable.

b. Prior to any lighting controls startup activity, provide the settings and time schedules to be used for the lighting controls and the process for determining any field adjustable settings, for the CxA and Design Professionals to review (if not fully defined in the sequence of operation). The target / design light levels for determining any daylight harvest and/or task tuning control settings shall be obtained from the Design Professionals.
c. Conduct representative, sample light level measurements, as applicable for determining and/or verifying settings for task tuning, scene settings or other control functions per the sequence of operation.

d. Schedule and conduct a field demonstration of the final lighting control settings (including field adjustable ones) and pre-programmed scenes for a few representative initial installations, for the CxA, Owner and Design Professionals to review prior to the completion of all controls.

e. Submit a Lighting Systems and Controls IV and PFCT Plan with blank forms, for review by the CxA, at least 4 weeks in advance of conducting any IV. The Plan shall include the following items:

1) The representative blank IV forms to be used by the Electrical Trade Subcontractor to verify installation of the lighting fixtures and the applicable lighting control system sensors, devices (including switches), UL924 relays, and controllers, per the design and manufacturer requirements.

   a) These IV forms can be shop or submittal drawing plans that are field verified (for example, with checkmarks next to the individual fixtures and the associated control system sensors, devices, relays and controllers to indicate the IV was complete), or checklists that are completed on a room by room basis to verify installation of all lighting fixtures and all control system sensors, devices, relays and controllers.

   b) The intent of these IV forms is to verify the installation of the lighting fixtures and lighting control system sensors, devices, relays and controllers by the Electrical Trade Subcontractor prior to the lighting control system programming, startup and pre-functional checks and tests.

2) The representative blank Startup and PFCT forms to be used for the lighting control system. These forms shall verify the following Startup and PFCT tasks, where applicable:

   a) All lighting control system sensors, devices and controllers have been checked (on a room or area basis) to confirm they are properly installed, programmed, and communicating, and are operating correctly.

   b) All lighting control system sensor and device settings have been programmed, checked and adjusted for occupancy, vacancy, motion grouping, dimming, pre-programmed scene and daylight harvest control functions, per the sequence of operation.

   c) Representative light level measurements have been performed and documented (where required) by the Electrical Trade Subcontractor and/or the Lighting Controls Manufacturer’s Representative, and the settings for task tuning, scenes and other control functions have been programmed appropriately per the sequence of operation and the light level measurements, where applicable.

   d) The sequences of operation for each room and the entire building have been fully programmed, checked and pre-tested, including any global (building wide) sequences and settings for time schedules, demand respond, etc.

   i. The PFCT forms can be shop or submittal drawing plans that are field verified (for example, with checkmarks next to each room or area), or checklists that are completed on a room by room basis to verify the sequence programming and to document the completed pre-functional tests.
e) Any control system network communication and software checks, trend log configuration checks, alarm configuration checks, and graphical display checks.

f. Submit a Receptacle Control IV and PFCT Plan with blank forms, for review by the CxA, at least 4 weeks in advance of conducting any IV. The Plan shall include the following items:

1) The representative blank IV forms to be used by the Electrical Trade Subcontractor to verify installation of the receptacle load control sensors, devices, relays, and controllers, per the design and manufacturer requirements.

   a) These IV forms can be shop or submittal drawing plans that are field verified (for example, with checkmarks next to the associated sensors, devices, relays and controllers to indicate the IV was complete), or checklists that are completed on a room by room basis to verify installation of all sensors, devices, relays and controllers.

   b) The intent of these IV forms is to verify the installation of the sensors, devices, relays and controllers by the Electrical Trade Subcontractor prior to the control system programming, startup and pre-functional checks and tests.

2) The representative blank Startup and PFCT forms to be used for the receptacle control system. These forms shall verify the following Startup and PFCT tasks, where applicable:

   a) All control system sensors, devices, relays and controllers have been checked (on a room or area basis) to confirm they are properly installed, programmed, and communicating, and are operating correctly.

   b) All control system sensor and device settings have been programmed, checked and adjusted for occupancy and vacancy receptacle load control (switching) functions, per the sequence of operation.

   c) The sequences of operation for each room and the entire building have been fully programmed, checked and pre-tested, including any global (building wide) sequences and settings for time schedules, demand respond, etc.

      i. The PFCT forms can be shop or submittal drawing plans that are field verified (for example, with checkmarks next to each room or area), or checklists that are completed on a room by room basis to verify the sequence programming and to document the completed pre-functional tests.

   d) Any control system network communication and software checks, trend log configuration checks, alarm configuration checks, and graphical display checks.

f. For projects with a central, networked lighting control system, prior to conducting the FPTs, meet with the CxA to review the programmed sequences of operation and sample system graphics with the CxA.

   1) The lead programmer from the Lighting Controls Manufacturer’s Representative shall be in attendance.

   2) The intent of this requirement is to reduce field testing time by reviewing with the CxA the actual programmed sequence logic and graphics relative to the approved submittal and sequences, in order to confirm the actual programming and graphics prior to field testing, and to allow for any changes and adjustments.

   3) The meeting duration time is estimated to not be more than 1 day in duration.
h. Prior to conducting the CxA witnessed FPTs, place the systems and controls into the operating modes intended for testing. Check all control system alarms and interlocks with other systems during each mode of operation prior to functional testing. Ensure all systems are operating and performing per the requirements of the contract and design documents, and have been pre-tested per the FPTs, and are ready for the CxA witnessed FPTs.

1) The Trade Subcontractors shall determine the appropriate level of pre-testing, to prepare for the CxA witnessed FPTs.

i. The FPTs for daylight harvest controls shall be conducted at both night-time periods (in order to test and verify targeted task light levels are maintained without daylighting) and during day time periods.

j. Set up the appropriate control system trends per the final FPT forms provided by the CxA and provide trend data into a usable electronic format files, such as a text, CSV or Excel format to the CxA. The CxA will analyze and review the trend data.

1) The trend points list may include both hardware (inputs, outputs) and virtual / software points. The appropriate trend intervals and minimum duration will be provided on the FPT forms.

2) As an Owner approved alternative, the Trade Sub-Contractor may provide the CxA remote access to the control system, with Owner permission, that will allow the CxA to directly download the trend data files.

k. Provide trend data to the CxA during the post-occupancy warranty phase for review by the CxA, where required.

1.9. SUBMITTAL REQUIREMENTS FOR COMMISSIONING

A. Trade Subcontractor Commissioning Forms. The Trade Subcontractors shall submit to the CxA all applicable representative, blank forms and plans for IV, Startup and PFCT tasks for the project (as listed in 1.8 Trade Subcontractor Responsibilities), at least 4 weeks in advance of performing any of these tasks.

1. The draft SRC forms issued by the CxA will list the required IV, Startup and PFCT forms and plans, required for this project. The Trade Subcontractor shall review the draft SRCS to ensure all applicable, representative IV, Startup and PFCT forms and plans have been submitted for the CxA review.

2. The CxA will review these submitted commissioning forms including whether all project specific requirements are included.

3. The CxA may request additional data, changes and/or additions to these forms to confirm application prior to their use. If the Trade Subcontractor cannot submit sufficient forms, the CxA will provide forms based on the construction documents and specifications, manufacturer installation manuals and procedures, and/or industry standards or guidelines.

B. Training Agenda. The Trade Subcontractors shall develop a Training Agenda for each training session, per the requirements of the contract documents and specifications, and the LEED Enhanced Commissioning requirements, and may include both operations and maintenance (O&M) staff training and occupant training. The Training Agenda shall be included in the comprehensive Training Plan to be submitted by the GC for review by the Design Professionals, GC and/or the Owner (see Section 01 91 13). The GC and Trade Subcontractors shall coordinate to fully develop the comprehensive Training Plan with input from the Owner.
1. The Training Agenda for each training session shall include the following:
   a. equipment and/or systems covered;
   b. recommended attendees;
   c. proposed location;
   d. estimated duration;
   e. level of instruction to be provided and an outline of the training topics and subjects to be covered;
   f. list of any materials and handouts to be provided (or provided in advance);
   g. company to provide the training and the instructor's name and qualifications.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1. MEETINGS, SCHEDULING AND COORDINATION
   A. See Section 01 91 13.

3.2. DOCUMENTATION
   A. The Trade Subcontractors have specific responsibilities for assisting in the development of equipment check, test and verification procedures and forms, and in performing and documenting commissioning tests, as directed by the CxC and as overseen by the CxA.

   B. The Trade Subcontractors shall provide, wherever the Contract Documents require, system checks and testing, test reports, factory test data and reports, checklists, operational verifications and demonstration, etc., whether specified or not in the commissioning sections.

3.3. TEST EQUIPMENT
   A. The Trade Subcontractor shall provide all test equipment in sufficient quantities to execute all Pre-Functional and Functional Performance Tests in an expedient fashion.

   B. The test equipment shall be of industrial quality and suitable for testing and calibration with accuracy within the tolerance necessary to demonstrate system performance per the Contract Documents. If not otherwise specified, the following minimum requirements apply:

   1. Light meters shall have an accuracy of \( \pm \) 5.0 percent of the full scale and have been calibrated within the last year per NIST standards.

   C. The test equipment shall have calibration certification per equipment manufacturer's interval level or within one year if not otherwise specified. The calibration tags shall be affixed or certificates readily available for all test equipment.

3.4. SYSTEM READINESS: INSTALLATION VERIFICATION, STARTUP, PRE-FUNCTIONAL CHECKS & TESTS
   A. The Trade Subcontractors shall conduct all startup procedures and tests without compromise to human or equipment safety. The GC and Trade Subcontractors shall be responsible for the liability and safety of conducting all startup, checks and tests.
B. The Trade Subcontractors shall clearly identify and list any issues and deficiencies resulting from the IV, Startup and PFCT tasks on the associated forms and immediately notify the CxA. The CxA will additionally document the issues on the Cx Log. Once issues and deficiencies are corrected and verified, the associated forms shall be updated and resubmitted, and any necessary field review, back-checks or re-tests witnessed by the CxA.

C. The CxC and Trade Subcontractors shall provide a minimum 10 days’ notice to the CxA for witnessing equipment Startup and PFCT tasks.
   1. The sample rates for the CxA witnessing of electric system PFCT tasks and startups, will be defined in the Cx Plan.

D. The GC and Trade Subcontractors shall ensure the completion of the SRC forms. Review and approval of the completed SRC forms by the CxA is required prior to conducting the FPTs.

3.5. FUNCTIONAL PERFORMANCE TESTS

A. The Trade Subcontractors shall perform all FPTs per the final FPT forms and complete the Title 24 Part 6 acceptance test requirements and Certificate of Acceptance forms, for all systems and equipment in the scope of commissioning. The FPTs shall be witnessed by the CxA. The Trade Subcontractors may need to complete off hours or weekend work in order to complete the FPTs.

B. The CxA will document all testing results on the FPT forms, not including the Title 24 Certificate of Acceptance forms. The completion of the Title 24 Certificate of Acceptance forms is a contractor responsibility.

C. As outlined in the Part 1 general commissioning process, a sampling approach shall be used for the FPTs of identical systems and equipment, using the sample rates as defined in the Cx Plan, with the specific systems and equipment selected by the CxA.

D. The Trade Subcontractors shall determine what level of pre-testing is appropriate in order to prepare for the CxA witnessed FPTs.

E. The CxC and Trade Subcontractors shall coordinate all FPTs with the CxA, and provide a minimum of 10 days’ notice prior to conducting each test.

F. The GC and Trade Subcontractors shall have responsibility for the liability and safety of conducting all functional performance tests.

G. The Trade Subcontractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. to execute the test according to the test procedures.
   1. The Trade Subcontractors shall provide any necessary control system global or system level commands and setpoint adjustments necessary to conduct the testing as called out in the FPT procedures.

H. At completion of the test, the Trade Subcontractor shall return all affected building equipment and systems to their pre-test normal condition.

3.6. FUNCTIONAL PERFORMANCE TESTS – TREND ANALYSIS
A. The CxA may conduct trend analysis as part of the FPT process, after completion of the onsite field conducted FPTs and correction of all issues and deficiencies, to verify integrated system operation and performance.

B. The CxA will prepare a lighting controls system trend points list including the trend interval. The Electrical Trade Contractor, Lighting Trade Contractor or Lighting Control Manufacturer's Representative shall set up the trend log definitions prior to the start of the sequence of operation FPTs.

C. The Trade Subcontractors or Lighting Control Manufacturer's Representative shall provide the trend to the CxA in an electronic format, either a text file, CSV file or Excel file, with related system parameters grouped together. The estimated duration for the trend data is 1 to 3 weeks (with a minimum of 1 weeks' worth of data).

D. If the CxA discovers any control or performance issues during trend analysis, the Trade Subcontractors or Lighting Control Manufacturer's Representative shall correct the issues and provide new trend data for analysis verification by the CxA.

3.7. COMMISSIONING ISSUES, BACK-CHECKS AND RE-TESTS

A. When Cx issues are identified during testing, the CxA will discuss with the executing Trade Subcontractor and/or CxC and determine whether or not testing can proceed. The CxA may allow immediate correction of minor issues and deficiencies identified during testing. The Cx issue and any identified resolution will be documented on the test form in use in addition to the Cx Log.

B. The CxA will maintain and update the Cx Log, and document the issue resolution process. Copies will be distributed to the GC, Owner, and Trade Subcontractors as appropriate. The Trade Subcontractors shall provide updates and comments regarding issue status and resolution.

C. The Trade Subcontractors shall promptly correct all Cx issues. The responsible party shall correct the issue and inform the CxC and CxA of the resolution and completion date, and update the Cx Log accordingly (in the fields assigned for contractor updates).

D. The CxA will record completion on the Cx Log after a successful witnessed re-test, field review, back-check, verification obtained through appropriate documentation or photographs, or acceptance by the Design Professional or Owner. The CxC shall reschedule any applicable re-testing with the CxA and Trade Subcontractor. The Trade Subcontractor shall retest until achievement of passing performance or Owner acceptance of the noted issue.

1. Where sampling is used for the PFCTs and FPTs, the results shall be deemed acceptable once all noted issues are resolved and any new sample tests or checks have passed.

E. Additional parties may require input during a dispute regarding a Cx issue. Regardless of the validity or responsibility of the issue, the CxA will have the final interpretive authority on Cx issues and the Owner will have the final approval authority.

F. The CxA may recommend solutions to Cx issues. However, the GC and Trade Subcontractors ultimately have the burden of responsibility to solve, correct and perform required retests.

G. Back-checks, Verifications and Re-testing:

1. The CxA will witness one (1) re-test or will perform one (1) field back-check / verification of any Cx issue.
2. The CxA’s total onsite time for re-test witnessing and field verification or back-check of Cx issues will be limited to no more than 2 work days (full 8-hour work days) for all applicable systems in the commissioning scope.

3. The Owner may back-charge the GC for any additional fees from the CxA, resulting from any additional re-testing or field back-checks or verification beyond this allocated total time.

4. The CxC must provide a minimum 48 hours’ notice for scheduling any re-testing, though the CxA will attempt to accommodate a shorter timeframe if feasible.

5. Any required re-testing shall not be considered a justified reason for a claim of delay or for a time extension.

H. For any re-testing required, the CxA will determine if the entire test must be re-tested or if it is acceptable to re-test specific portions of the test that had failed.

3.8. DEFERRED & SEASONAL TESTING

A. Before or during the end of the first year warranty period, the Trade Subcontractor shall complete any seasonal or deferred testing, required per the design specifications and as defined in the Cx Plan. The Trade Subcontractors shall complete tests in the same manner as all other commissioning tests, including CxA witnessing.

B. The CxC and Trade Subcontractor shall coordinate with CxA and Owner and schedule all deferred and seasonal testing.

3.9. TRAINING VERIFICATION

A. The CxC and Trade Subcontractors shall coordinate and schedule the training for the Owner’s facility and operations personnel, and building occupants. The CxC shall ensure that training is completed per the requirements of the contract documents and specifications.

B. Trade Subcontractors responsible for specific equipment and system training shall submit to the CxC, a written training agenda for each training class for the equipment and systems to be commissioned. The GC shall submit a comprehensive Training Plan, including the specific training agendas, to Owner, Design Professionals and CxA for review and approval. See also Section 01 91 13.

C. The CxA will review the Training Plans for commissioning verification prior to conducting the actual training.

D. For verification of actual training conducted, the CxC shall submit to CxA ‘attendee signed’ attendance sheets for each training session conducted and a copy of any final training presentations or handout materials.

3.10. COMMISSIONING ACCEPTANCE, CLOSE-OUT AND REPORTING

A. Completion of the main commissioning activities (system readiness checks, functional performance testing, and training) shall be accomplished as a prerequisite for substantial completion. Completion of any re-testing shall be completed prior to final acceptance of commissioning.

B. After completion of the main commissioning activities and following review of the completed commissioning documents, test results and the current Cx Log with the Owner, the Owner will indicate whether they accept completion of the project construction phase commissioning or if
not, the requirements for acceptance. Upon Owner acceptance, any remaining open Cx issues will be transferred to the warranty phase Cx Log for tracking resolution and completion as part of the warranty phase commissioning.

C. Upon completion of all commissioning activities, the CxA will prepare and submit to the Owner a Cx Report detailing all completed commissioning activities and documentation. The CxC shall support this effort by providing all GC and Trade Subcontractor commissioning documentation.

D. The CxA will complete a Systems Manual for the systems and equipment commissioned, following the LEED requirements, with assistance provided by the CxC and Trade Subcontractors. The Systems Manual will provide the operating staff the information needed to understand and optimally operate the commissioned systems. It will also include the current facility requirements, O&M preventative maintenance information, and an ongoing commissioning plan. Per LEED enhanced commissioning requirements, the Systems Manual will contain the following sections and detail:

1. Current facility requirements including the final version of the BOD and systems narrative.
2. Final equipment list.
3. Systems single line diagrams or schematics.
4. Final as-built sequence of operations, control drawings (P&IDs), points lists and setpoints.
5. Additional operating instructions for key systems or integrated building systems such as water-side and air-side HVAC systems and controls, lighting controls, etc.
6. Recommended schedule of major preventative maintenance requirements and frequency.
7. Ongoing Cx Plan
   a. Definition of the ongoing commissioning process, defined roles and responsibilities, a recommended schedule for recommissioning the systems;
   b. Recommended schedule for retesting of commissioned systems with blank test forms from the Final Commissioning Plan.
   c. Recommended schedule for calibrating sensors and actuators.

3.11. POST-OCCUPANCY WARRANTY PHASE COMMISSIONING

A. The Trade Subcontractors shall execute any defined seasonal or deferred FPTs, witnessed by the CxA.

B. The CxA may review BAS or lighting control system trend data during the Warranty Phase. The BAS Trade Contractor shall be responsible for providing post-occupancy trend data to the CxA.

C. The CxA will report any identified issues and recommendations to the CxC via a Warranty Phase Cx Log for review and resolution by the GC and Trade Subcontractors prior to the end of the warranty period, for any issues or recommendations identified either by the CxA or the Owner. The CxC shall work with the Trade Subcontractors and O&M staff to make corrections and adjustments as required to address the issues and recommendations. The

D. Key representatives from the GC and Trade Subcontractors shall attend a near end of warranty commissioning review meeting, to be scheduled with the Owner’s facility staff and the CxA, no later than either 10 months after substation completion or two months prior to the expiration of the first 12-month warranty period of building occupancy.
1. During this meeting, the operation of the systems will be discussed with the Owner's staff, the results of any commissioning trend analysis will be reviewed and the warranty phase Cx Log will be reviewed. If needed, a walk-through of the systems with the Owner's staff will be conducted.

2. Next steps and actions items for any open Cx issues and recommendations will be discussed and documented via meeting minutes or a field report issued by the CxA. The intent is to resolve any open Cx issues prior to the end of the warranty phase.

E. After correcting noted Warranty Phase Cx issues, the CxC shall notify the CxA, and the CxA will back-check and verify resolution of the warranty phase Cx issues and recommendations.

F. Issues identified during the warranty period will remain warranty phase Cx issues until satisfactory completion by Trade Subcontractors, even if the warranty period expires during the correction and back-check period.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. Lighting controls shall be manual on/off dimming switches with occupancy/vacancy sensors as indicated on plans. Each room lighting circuit shall be controlled by a room controller in each respective room/zone. Each room shall have manual on/off switch(es) with full range dimming capability. Switches shall be low voltage type and shall be wired directly to each respective room controller. Occupancy/vacancy switches shall be low voltage type and shall be wired directly to each respective room controller. Occupancy sensors shall be programmed to be auto-on/auto-off. Vacancy sensors shall be programmed to be manual-on/auto-off.

B. Section Includes:
   1. Indoor occupancy sensors.
   2. Wall-box dimmers
   3. Wall-switch occupancy sensors

1.2 RELATED SECTIONS

A. Section 260519 Conductors and Cables
B. Section 260553 Identification
C. Section 262726 Wiring Devices

1.3 DEFINITIONS

A. PIR: Passive Infrared
B. SP: Single Pole
C. NECA 1: National Electrical Contractors Association Standard Practice of Good Workmanship
D. CBC: California Building Code, 2016 Edition
E. NFPA 70: California Electrical Code, 2016 Edition
F. UL 773 A: Underwriter’s Laboratory, Nonindustrial Photoelectric Switches for Lighting Control

1.4 ACTION SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For each type of product.

C. Shop Drawings: Show wiring & mounting details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field wiring.
   2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS
A. Manufacturers
   1. Watt Stopper
   2. Cooper Industries, Inc.
   3. Hubbell Building Automation, Inc.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Sensor Switch, Inc.
   6. Or, Equal

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
   4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
   5. Mounting:
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
   1. Sensitivity Adjustment: Separate for each sensing technology.
   2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
   3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Basis of design as shown on the drawings are products by Watt Stopper. Equivalent products may be provided by the following:
   1. Watt Stopper
   2. Cooper Industries, Inc.
   3. Hubbell Building Automation, Inc.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Sensor Switch, Inc.
   6. Or, Equal

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, and shall comply with California Title 24.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
   3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensors:
   1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft.
   2. Sensing Technology: Dual technology - PIR and ultrasonic.
   4. Voltage: Match the circuit voltage; dual-technology type.
   5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

D. Wall-Switch Sensor for square and near square rectangular rooms:
   1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft.
   2. Sensing Technology: PIR.
   3. Dual Relay.
   4. Switch Type: SP, manual "on," automatic "off."
   5. Voltage: Match the circuit voltage; dual-technology type.
   6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
   7. Retain one of two "off" time-delay subparagraphs below.
   8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
   9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

PART 3 - EXECUTION

3.1 SENSOR PLACEMENT

A. Coordinate layout of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Place and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTORS

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are placed in an enclosure with factory-mounted vibration isolators.

3.3 WIRING

A. Wiring Method: Comply with Section 260519 Conductors and Cables.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 Identification.
   1. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Operational Test: After providing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit District Representative’s operations.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train District Representative's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION
SECTION 26 09 43
NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SCOPE

A. Section includes manually operated lighting controls with relays and control module.

1.2 RELATED SECTIONS:

1. Section 260519 Conductors and Cables
2. Section 260523 Control Voltage Electrical Power Cables
3. Section 260553 Identification
4. Section 260923 Lighting Control Devices
5. Section 262726 Wiring Devices

1.3 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. BAS: Building automation system.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

E. PC: Personal computer; sometimes plural as "PCs."

F. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

G. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

H. UTP: Unshielded twisted pair.

I. NFPA 70: California Electrical Code, 2016 Edition

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.
C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
   3. Block Diagram: Show interconnections between components specified in this Section and devices provided with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
   4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

D. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

E. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

F. Field quality-control reports.

G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

I. Warranty: See Article 1.6 Warranty.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.
1.6 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of lighting control functions.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of software input/output to execute switching or dimming commands.
      b. Failure of modular relays to operate under manual or software commands.
      c. Damage of electronic components due to transient voltage surges.
   2. Warranty Period: Two years from date of Notice of Completion.
   3. All items of Labor shall be included.

1.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Provide and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.
   1. Provide 30 days' notice to District's Representative to allow scheduling and access to system and to allow District's Representative to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acuity Brands Lighting, Inc.; Lithonia Lighting brand.
   2. Greengate by Cooper Controls.
   4. Lighting Control & Design, Inc.
   5. Watt Stopper/Legrand.
   6. Or, Equal
2.2 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Performance Requirements: Manual switch operation sends a signal to network-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

C. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.

   1. ASHRAE 135 (BACnet) and Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

2.3 CONTROL MODULE

A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.

   1. Display: Single graphic display for programming lighting control panelboards.

   2. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.

   3. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.

   4. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.

   5. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.

   6. Astronomic Control: Automatic adjustment of dawn and dusk switching.

   7. Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.

   8. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device.
On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.

a. Software shall interpret status signals, provide for their display, and initiate failure signals.

b. Lamp or LED at control module or display panel shall identify status of each controlled circuit.

9. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over telephone lines. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.

10. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.

11. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override. Comply with provisions in California Code of Regulations, Title 24, Part 6.

12. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.

13. Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming fluorescent ballast control circuits. Signal shall control dimming of fixture so illumination level remains constant as daylight contribution varies.

14. Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.

15. Energy Conservation: Bi-level control of special ballasts or dimming circuits to comply with local energy codes.

16. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

17. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

18. Additional Programming: In addition to system programming by the PC, individual control modules shall be networked and programmable using data-entry and -retrieval (such as wired Ethernet hubs, wireless IEEE 802.11 hubs).

2.4 POWER DISTRIBUTION COMPONENTS

A. Modular Relay Panel: Comply with UL 508 (CAN/CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Cabinet: Steel with hinged, locking door.

   a. Barriers separate low-voltage and line-voltage components.
b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.

c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
   a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
   c. Endurance: 50,000 cycles at rated capacity.

B. Line-Voltage Surge Suppression: Factory provided as an integral part of 120- and 277-V ac, solid-state control panels.

2.5 MANUAL ANALOG SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
   1. Match color specified in Division 26 Section "Wiring Devices."

B. Wall Plates: Single and multi-gang plates as specified in Division 26 Section 262726 "Wiring Devices."

C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

A. Connection Type: RS-485 protocol, category 5e UTP cable, using RJ45 connectors. Power shall be from the control unit.

B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
   1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Section 262726 "Wiring Devices."
   2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Conductors and Cables."

B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multi-conductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 Conductors and Cables.

C. Class 1 Control Cables: Stranded copper, complying with UL 83, multi-conductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Conductors and Cables."
D. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

E. RS-485 communications require two twisted pairs. Circuit is limited to a distance of not more than 4000 feet (1220 m).

F. RS-485 Cables:
   1. Standard Cable: NFPA 70, Type CM.
      a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
      b. PVC insulation.
      c. Unshielded.
      d. PVC jacket.
      e. Flame Resistance: Comply with UL 1581.

PART 3 - EXECUTION

3.1 WIRING

   1. For power wiring comply with Section 260519 Conductors and Cables.
   2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Section 260523 Control-Voltage Electrical Power Cables.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Provide field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

F. Identify components and power and control wiring according to Section 260553 Identification.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment, including connections, and to assist in testing.

B. Tests and Inspections:
1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by District’s Representative.

C. Lighting controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 SOFTWARE

A. Provide and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software. Final programming will be provided to the District’s Representative and schedules will be confirmed with the District’s Representative prior to Acceptance.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train District’s Representative(s) to adjust, operate, and maintain lighting controls. A minimum of 4 hours of training shall be provided to the District’s Representative at no additional expense to the District.

1. It is required that training is provided to the District’s Representative(s) prior to Acceptance and a typewritten acknowledgement of who provided the training and who attended the training shall be submitted to the District’s Representative and included in the Operations and Maintenance manuals.

END OF SECTION
SECTION 26 12 00
MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following types of transformers with medium-voltage primaries:
   1. Pad-mounted, liquid-filled transformers.

1.3 DEFINITIONS

1.4 SUBMITTALS
A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

B. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Underground primary and secondary conduit stub-up location.
   2. Dimensioned concrete base, outline of transformer, and required clearances.
   3. Ground rod and grounding cable locations.
   4. Dimensional drawings in relation to existing and new switchgear in space allotted.
   5. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Follow-up service reports.

G. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Elec-
Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C2.


F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions except for the following:
   1. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
   2. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
   3. Unusual transportation or storage conditions.
   4. Unusual grounding-resistance conditions.
   5. Unusual space limitations.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Industries; Cooper Power Systems Division.
   2. ABB Control, Inc.
   3. Or, Equal
2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS


B. Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

C. Insulation Temperature Rise: 55 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.

D. Basic Impulse Level: 95 kV.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. High-Voltage Switch: 200 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for loop feed with 3-phase, 4-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.
   1. Bay-O-Net liquid-immersed fuses that are externally replaceable without opening transformer tank.

H. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
   1. Bushing-Well Inserts: One for each high-voltage bushing well.
   2. Parking Stands: One for each high-voltage bushing well.
   3. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

I. Accessories:
   1. Drain Valve: 1 inch (25 mm), with sampling device.
   2. Dial-type thermometer.
   3. Liquid-level gage.
   4. Pressure-vacuum gage.
   5. Pressure Relief Device: Self-sealing with an indicator.
   8. Alarm contacts for gages and thermometer listed above.
2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90.

B. Factory Tests: Perform the following factory-certified tests on each transformer:
   1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
   2. Ratios on rated-voltage connection and on tap extreme connections.
   4. No-load loss at rated voltage on rated-voltage connection.
   5. Excitation current at rated voltage on rated-voltage connection.
   6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
   8. Induced potential.
   9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
      a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:
   1. Wiring entries comply with layout requirements.
   2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Install transformers on concrete bases.
   1. Anchor transformers to concrete bases according to structural details in the drawing set."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
   1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
   2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Test Reports: Prepare written reports to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: If requested by Owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:
   1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology
standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.


B. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.2 RELATED SECTIONS

A. Division 03 Concrete
B. Section 260519 Conductors and Cables
C. Section 260526 Grounding and Bonding
D. Section 260548 Vibration and Seismic Controls
E. Section 260553 Identification

1.3 DEFINITIONS

A. IEEE: Institute of Electrical Electronic Engineers
B. NFPA 70: California Electrical Code 2016
C. NETA: International Electrical Testing Association
D. NRTL: Nationally Recognized Testing Laboratory
E. NEMA: National Electrical Manufacturer's Association
F. UL: Underwriter's Laboratory
G. ASTM B 3: Standard Specification for Soft or Annealed Copper Wire
H. ASTM B 33: Standard Specification for Tinned Soft or Annealed Copper Wire

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, devices and features, and performance for each type and size of transformer indicated.
C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
D. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 Section Vibration and Seismic Controls. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their mounting requirements.

E. Qualification Data: For testing agency.

F. Source quality-control test reports.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

I. Warranty: See Article 1.7 Warranty

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: NETA certified for on site testing.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 032000 Concrete Reinforcing.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Notice of Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer:
   1. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp
   2. Eaton Electrical Inc.; Cutler-Hammer Products.
   5. MGM
   6. Or, Equal

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
   1. Provide with Rodent screens.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Copper, unless otherwise noted on the drawings.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548 Vibration and Seismic Controls.

C. Cores: One leg per phase.

D. Enclosure: Ventilated switchboard type, NEMA 250, Type 3R located outdoors.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Electro statically applied polyester custom color coat. Color to be selected by District’s Representative at time of submittals.

F. Taps for Transformers Smaller Than 3 kVA: None

G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Transformers shall have energy efficiencies that meet or exceed the latest requirements of the US Department of Energy’s Candidate Standard Level Three (CSL-3) efficiency, with extremely low no load losses.
   2. Transformers shall be designed to an efficiency standard higher than the latest requirements of the California Code of regulations Title 20 and Title 24 and DOE 2016.
   3. Tested according to NEMA TP 2.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.
   3. Shield Effectiveness:
       a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
       b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
       c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

2.4 Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
   A. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
      1. 9 kVA and Less: 40 dBA
      2. 30 to 50 kVA: 45 dBA
      3. 51 to 150 kVA: 50 dBA
      4. 151 to 300 kVA: 55 dBA
      5. 301 to 500 kVA: 60 dBA
      6. 501 to 750 kVA: 62 dBA
      7. 751 to 1000 kVA: 64 dBA

2.5 IDENTIFICATION DEVICES
   A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution / buck-boost transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 Identification.

2.6 SOURCE QUALITY CONTROL
   A. Test and inspect transformers according to IEEE C57.12.91.
   B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be located.

D. Verify that ground connections are in place and requirements in Section 260526 Grounding and Bonding have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PLACEMENT

A. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260548 Vibration and Seismic Controls.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 Grounding and Bonding.

B. Connect wiring according to Section 260519 Conductors and Cables.
   
   1. Torque connections per manufacturer's listed specifications. In the absence of manufacturer's torque specifications use torque values recommended by NETA.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not
being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION
SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.
   2. Disconnecting and overcurrent protective devices.
   3. Identification.

1.2 RELATED SECTIONS

A. Division 3 Concrete
B. Section 260519 Conductors and Cables
C. Section 260526 Grounding and Bonding
D. Section 260529 Hangers and Supports
E. Section 260553 Identification

1.3 DEFINITIONS

A. NETA: International Electrical Testing Association
B. NRTL: Nationally Recognized Testing Laboratory
C. NEMA: National Electrical Manufacturer’s Association
D. NECA: National Electrical Contractors Association
F. CBC: California Building Code, 2016 Edition
G. UL: Underwriters Laboratory
H. CEC: California Electrical Code, 2016 Edition
I. OSHA: Occupational Safety & Health Administration

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For each type of switchboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
C. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of devices, equipment features, and ratings.

2. Detail enclosure types for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.


5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

D. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals include the following:
   1. Routine maintenance requirements for switchboards and components.

F. Warranty: See Article 1.8 Warranty.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 122 deg F.
      b. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied unless permitted under the following conditions:
   1. Notify District's Representative in advance of proposed interruption of electric service
per Section 011400 "Work Restrictions".
2. Do not proceed with interruption of electric service without District Representative’s written permission.
3. Comply with NFPA 70E, Electrical Safety in the Workplace.

1.8 COORDINATION

A. Coordinate layout and placement of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.9 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Notice of Completion.

1.10 EXTRA MATERIALS

A. Provide extra materials that match products provided and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses for fused power-circuit devices: Equal to 10 percent of quantity required for each size and type, but no fewer than 3 of each size and type.
   2. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers:
   1. IEM / Capital Power Products Type SWBD with General Electric breakers.
   2. Eaton.
   3. General Electric Spectra Series (Bolt-On to the bus style).
   4. Or Equal

B. Distribution Switchboards: Power and feeder distribution type.
   1. NEMA 250 3R enclosure with screened venting and base channels.
      a. The enclosure shall have 2 screened vents with filters, top and bottom on each side to vent the interior section.
      b. Each door shall have 2 screened vents with filters top and bottom to vent the vestibule.

C. Doors: Secured with pad locking provisions.
   1. For doors more than 36 inches high, provide 3 point latch.
2. Door-in door construction

D. Mains: As indicated in the panel schedules and one line diagrams.

E. Provide each switchboard section and distribution panels with thermostatically controlled heat strip.

F. Provide a two party pad lock provision on the main switchboard utility metering section.

G. Dead front type completely metal enclosed, self-supporting structure of the universal frame type using die-formed, welded and bolted members. Formed ends sectionalized and removable with screw-on plates and NEMA 3R top covers, front facing side covers formed hinged with brass knurled knobs and concealed hinges. Finish gray, ASA70 dry powder polyester plastic electro statically applied, meeting a 3,000 hour salt spray test.
   1. Base Channels shall be 7 gage or thicker steel
   2. Structures shall be 12 gage or thicker
   3. Covers shall be 12 gage or thicker
   4. Top cover shall be 14 gage or thicker

H. All bussing shall be copper with silver plated connections and joints sized to limit temperature rise of 55 degrees centigrade per UL standards, and in all cases shall not be sized smaller than 1000 Amps/square inch of cross sectional area, braced to withstand a minimum short circuit current conforming to the power system study results. All busses shall be rated 100 percent and shall extend full length of usable space. Incoming supply lugs shall be at the top or bottom of the bus, not at the center. Flex bus is not permitted. Tapering of the horizontal or vertical bus is not permitted.
   1. AIC rating shall conform to the power system study results. Value is 100k AIC unless specified otherwise on the one line diagram.

I. Breakers shall be bolt-on to the bus type with frame and minimum symmetrical amp rating as indicated on Drawings. The rating shall be full symmetrical amp rating and series rated only when specifically noted in the drawings. 250A frames and larger shall be interchangea-ble trip type. All breakers shall be provided with factory padlocking provisions. All breakers shall be listed for termination of copper, copper clad, or aluminum conductors insulated at 75 degree C temperature rating or higher. All breaker lugs shall be copper.
   1. Circuit breakers serving motor loads utilizing variable frequency drives shall be Eaton Series G, HFD Frame or larger with fixed trip units or Equal.
   2. Breakers shall be thermal-magnetic type common trip with one operating handle.

J. Conduits shall enter cabinet through neat holes and perpendicular to entrance face. Lace all conductors with Nylon Tie-Wraps. Provide laminated acrylic nameplates at all breakers.

K. Where spaces are indicated on the Drawings, all required hardware and trim shall be provided to allow future placement of breakers.

L. Provide equipment completely factory assembled, wired and tested before delivery and shall bear UL labels. Design shall meet CEC, NEMA and OSHA requirements.

M. Manufacturer shall provide equipment to meet the space provided, and shall not reduce the number of sections shown on the drawings.
N. Switchgear enclosures and distribution panels that are located in exterior locations exposed to weather shall have thermostatically controlled heat strips.

O. All switchgear/electrical equipment shall be labeled with warnings to qualified personnel of the potential arc flash hazards and the appropriate personal protective equipment (PPE) required, per the latest issue of the CEC and NFPA-70E.

P. Provide a minimum of 25 percent of space for spare capacity.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA and NEMA standards.

B. Examine switchboards before mounting. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with manufacturer’s tolerances and other conditions affecting performance of the Work.

D. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PLACEMENT

A. Place switchboards and accessories according to NECA and NEMA standards.
   1. Equipment Mounting: Locate switchboards on concrete base as detailed in the drawings.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

C. Utilize filler plates in unused spaces of panel-mounted sections.

3.3 IDENTIFICATION

A. Identify field-provided conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification."

C. Device Nameplates: Label each disconnecting and overcurrent protective device with a nameplate complying with requirements for identification specified in Section 260553 "Identification."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: After Notice of Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION
SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE

A. Section includes:
   1. Distribution Panelboards
   2. Disconnecting and Overcurrent Devices

1.2 RELATED SECTIONS

A. Section 260519 Conductors and Cables
B. Section 260526 Grounding and Bonding
C. Section 260529 Hangers and Supports
D. Section 260553 Identification

1.3 DEFINITIONS

A. NETA: International Electrical Testing Association
B. NRTL: Nationally Recognized Testing Laboratory
C. NEMA: National Electrical Manufacturer's Association
D. NECA: National Electrical Contractors Association
F. CBC: California Building Code, 2016 Edition

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.

B. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus dimensions, configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices. Fully rated panels and devices are required.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

6. Include wiring diagrams for power, signal, and control wiring.

D. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For application in panelboards. Provide final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Operation and Maintenance Data, include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

G. Warranty: See Article 1.10 Warranty

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member Company of NETA or an NRTL.
   1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1, Standards for Panelboards.


F. Comply with UL489 Molded-Case Circuit Breakers and Circuit Breaker Enclosures, UL50 Enclosures for Electrical Equipment, UL 67 Panelboards and UL 98 Enclosed and Dead Front Switches.

G. Panelboards shall be qualified for use in seismic areas as follows:
   1. High seismic loading as defined in CBC 16A
   2. Seismic compliance shall be qualified only through shake table testing. Compliance by calculation is not acceptable.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; provide temporary electric heating (75 Watts per panelboard) to prevent condensation.

B. Handle and prepare panelboards according to NEMA PB 1.

C. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris and traffic.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 degrees Fahrenheit to plus 104 degrees Fahrenheit.
      b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied unless permitted under the following conditions:
   1. Notify District’s Representative no fewer than 7 business days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without District Representative’s written permission.
   3. Comply with NFPA 70E, Electrical Safety in the Workplace.

1.8 COORDINATION

A. Coordinate layout and placement of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.9 FIELD MEASUREMENTS

A. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in California Electrical Code.
1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Notice of Completion.

1.11 EXTRA MATERIALS

A. Coordinate with Section 262813 Fuses for quantities of spare fuses.

B. Provide extra materials that match products provided and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

2. Circuit Breakers: Spares as noted on the panel schedules with no less than 2 spares for each panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Arrangement as indicated on Drawings is based on IEM with General Electric devices. Panel class, size, breaker ratings, etc. shall be as shown on Drawings.

B. Manufacturers:

1. IEM with General Electric devices.

2. Eaton


4. Or, Equal

C. Outside finish, including a fully painted box, factory white enamel.

D. Enclosure shall be of code gauge galvanized steel with front trim, hinged door, door-in-door, and two (2) metallic semi-flush cylinder locks for each door. All panelboard locks keyed alike.

1. Door-in-door construction shall be hinged from the can and allow access to the side wireways/gutters without removing the dead front.

E. Multiple pole circuit breakers shall have internal common trip connections. All breakers shall be bolt-on to the buss type. All breakers shall be listed for termination of copper, insulated at 75 degree Centigrade temperature rating or higher. All breaker lugs shall be copper.

1. Breakers shall be fully rated for the symmetrical amp rating unless specified otherwise.

F. Busses shall be copper and extend full length of usable space. Provide copper ground bus complete with lugs, not insulated from enclosure.

G. The AIC rating shall conform to the power system study results. In no case less than 22k AIC.
H. Semi-recessed panels shall be provided with a wood or metal escutcheon return to wall finish, flush with edge of trim. Surface mounted enclosure trims shall be the same height and width as the box. Recessed (Flush) mount enclosure trims shall overlap the box by 3/4 inch on all sides.

I. Recessed cabinets shall be provided with a minimum of three 3/4 inch empty conduits stubbed and capped into the accessible space above ceiling. Drawings may require additional conduit stubs.

J. Provide panelboard with a “Metal Frame” directory card holder welded on the inside of the door with a clear plastic cover. Directories shall be typewritten to conform to circuit assignment at time of occupancy, stating type of load and location.

K. Mount wall panelboards with top at +6 feet-6 inches above the finished floor.

L. Conduits shall enter cabinet through neat hole and perpendicular to entrance face.

M. Provide equipment completely factory assembled, wired and tested before delivery, bearing UL labels. Design shall meet NEC, NEMA and OSHA requirements.

N. Main breakers, where specified, as part of a combination main and distribution section or panel, shall be located above or below distribution bussing and be connected such that normal load side of breakers is disconnected when breaker is in open position. Backwards connections are prohibited.

O. Where spaces are indicated on the Drawings, all required hardware and trim shall be provided to allow future installation of the circuit breaker.

P. All panelboards/ electrical equipment shall be labeled with warnings to qualified personnel of the potential arc flash hazards and note the appropriate level of appropriate personal protective equipment (PPE) required, per the latest issue of the NEC and NFPA-70E. Incoming Mains Location: As conditions warrant.

Q. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.

R. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future devices.

S. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals, 22,000 symmetrical amperes minimum rating.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers:
   1. IEM Type CDP with General Electric breakers.
   2. Eaton, Type PRL4.
   3. General Electric Spectra Series (Bolt-On to the bus style).
   4. Or equal

B. Distribution Panelboards: NEMA PB 1, power and feeder distribution type.
   1. NEMA 250 3R enclosure with screened venting and base channels.
a. The enclosure shall have 2 screened vents, top and bottom on each side to vent the interior section.

b. Each door shall have 2 screened vents top and bottom to vent the vestibule.

C. Doors: Secured with pad locking provisions.
   1. For doors more than 48 inches high, provide 3 point latch.
   2. Door-in door construction.

D. Mains: As indicated in the panel schedules.

E. Provide with thermostatically controlled heat strip.

F. Dead front type completely metal enclosed, self-supporting structure of the universal frame type using die-formed, welded and bolted members. Formed ends sectionalized and removable with screw-on plates and NEMA 3R top covers, front facing side covers formed hinged with brass knurled knobs and concealed hinges. Finish gray, ASA70 dry powder polyester plastic electro statically applied, meeting a 3,000 hour salt spray test.

G. Bussing shall be copper with silver plated connections and joints sized to limit temperature rise of 55 degrees Centigrade per UL standards.

H. Breakers shall be bolt-on to the bus type with frame and minimum symmetrical amp rating as indicated on Drawings. The rating shall be full symmetrical amp rating and series rated only when specifically noted in the Drawings. 250 amp frames and larger shall be inter-changeable trip type. All breakers shall be provided with factory installed padlocking provisions. All breakers shall be listed for termination of copper or aluminum conductors insulated at 75 degrees Centigrade temperature rating or higher. All breaker lugs shall be copper.
   1. Circuit breakers serving motor loads utilizing variable frequency drives shall be Eaton Series C, HFD Frame or larger with fixed trip units or equal.
   2. Breakers shall be thermal-magnetic type common trip with 1 operating handle and solid state 7 or 9 function trip unit.

I. AIC rating of 65k AIC unless noted otherwise on the drawings.

J. Conduits shall enter cabinet through neat holes and perpendicular to entrance face. Lace all conductors with Nylon Tie-Wraps. Provide laminated acrylic nameplates at all breakers.

K. Where spaces are indicated on the Drawings, all required hardware and trim shall be provided to allow future installation of breakers.

L. Provide equipment completely factory assembled, wired and tested before delivery and shall bear UL labels. Design shall meet CEC, NEMA and OSHA requirements.

M. Manufacturer shall provide equipment to meet the space provided, and shall not reduce the number of sections shown on the Drawings.

N. Switchgear enclosures that are installed in exterior locations exposed to weather shall have thermostatically controlled heat strips.

O. Switchgear/electrical equipment shall be labeled with warnings to qualified personnel of the potential arc flash hazards and the appropriate personal protective equipment (PPE) required, per the latest issue of the CEC and NFPA-70E.
P. Provide a minimum of 25 percent of space for spare capacity.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before placement. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with tolerances and other conditions affecting performance of the Work.

D. Proceed with Work only after unsatisfactory conditions have been corrected.

3.2 PANELBOARDS AND DISTRIBUTION PANELBOARDS

A. Mount panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting:
   1. For free standing distribution panelboards, secure epoxy-coated anchor bolts that anchor into structural concrete.
   2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions provided with items to be embedded.
   3. Secure anchor bolts to elevations required for proper attachment to panelboards.
   4. Level the free standing distribution panelboard so doors close properly without forcing into position.
   5. Rodent proof enclosure
      a. Grout bottom perimeter of enclosure.
      b. Seal conduits

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount distribution panel cabinet plumb and rigid without distortion of box.

E. Factory manufactured filler plates shall be placed over unused spaces.

F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

A. Identify conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 Identification.

B. Create a directory that indicates circuit loads after balancing panelboard loads; incorporate District Representative’s final room designations. Obtain approval before applying. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 Identification.

D. Label panels per source per CEC 408.4.

E. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 Identification.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Load Balancing: After Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.
PART 1 - GENERAL

1.1 SCOPE
   A. Section includes:
      1. Receptacles, receptacles with integral GFCI, and associated device plates.

1.2 RELATED SECTIONS
   A. Section 260519 Conductors and Cables
   B. Section 260553 Identification
   C. Section 260923 Lighting Control Devices

1.3 DEFINITIONS
   A. GFCI: Ground-fault circuit interrupter.
   B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
   C. NFPA 70: National Fire Protection Association Electrical Code
   D. NEMA: National Electrical Manufacturers Association

1.4 SUBMITTALS
   A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
   B. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authority having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers:
      2. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
      3. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
      4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
5. Or equal

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 standards for wall devices.
   1. Products:
      a. Leviton; 5352 (duplex)
      b. Cooper; 5352 (duplex)
      c. Hubbell; CR5352 (duplex)
      d. Pass & Seymour; 5352 (duplex)
      e. Or equal
   2. Duplex Convenience receptacles – premium industrial grade, 3 wire grounded, nylon face, white in color.

2.3 GFCI RECEPTACLES

A. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products:
      a. Cooper; GF20.
      b. Pass & Seymour; 2084.
      c. Or equal
   2. Duplex GFCI Convenience receptacles – premium industrial grade, 3 wire grounded, nylon face, white in color.
   3. Waterproof and gasketed lift cover listed for wet locations.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles: NEMA configuration as required to accommodate the project equipment and UL 498.
   1. Products:
      a. Leviton; 2310.
      b. Cooper; L520R.
      c. Hubbell; HBL2310.
      d. Pass & Seymour; L520-R.
      e. Or, Equal

2.5 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.6 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Products:
      a. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
      b. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
      c. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
      d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
      e. Or, Equal

C. Pilot Light Switches, 20 A:
   1. Products:
      a. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V
      b. Cooper; 2221PL for 120 V and 277 V.
      c. Hubbell; HPL1221PL for 120 V and 277 V.
      d. Pass & Seymour; PS20AC1-PLR for 120 V.
      e. Or, Equal
   2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:
   1. Products:
      a. Leviton; 1221-2L.
      b. Cooper; 2221L.
      c. Hubbell; HBL1221L.
      d. Pass & Seymour; PS20AC1-L.
      e. Or, Equal
   2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
   1. Products:
      a. Leviton; 1257.
      b. Cooper; 1995.
      c. Hubbell; HBL1557.
      d. Pass & Seymour; 1251.
e. Or, Equal

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
   1. Products:
      a. Leviton; 1257L.
      b. Cooper; 1995L.
      c. Hubbell; HBL1557L.
      d. Pass & Seymour; 1251L.
      e. Or, Equal

2.7 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. LED Dimmer Switches: Modular; compatible with dimmer drivers; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.8 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
   1. Continuously adjustable slider, 5 A.
   2. Three-speed adjustable rotary knob, 1.5 A.

2.9 OCCUPANCY SENSORS

A. Long-Range Wall-Switch Sensors:
   1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Watt Stopper (The); CX-100
      b. Hubbell; ATP1600WRP.
      c. Leviton; ODWWV-IRW.
      d. Pass & Seymour; WA1001.
      e. Or, Equal
   2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft.

B. Long-Range Wall-Switch Sensors:
   1. Products:
a. Watt Stopper (The); DT-200.

b. Hubbell; ATD1600WRP.

c. Leviton; ODW12-MRW.

d. Or, equal

2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

C. Wide-Range Wall-Switch Sensors:

1. Products:
   a. Watt Stopper (The); CX-100-3.
   b. Hubbell; ATP120HRP.
   c. Leviton; ODWHB-IRW.
   d. Pass & Seymour; HS1001.
   e. Or, Equal

2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

D. Exterior Occupancy Sensors:

1. Products:
   a. Watt Stopper (The); EW-100-120.
   b. Leviton; PS200-10.
   c. Or, Equal

2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.10 COMMUNICATIONS OUTLETS

A. Telephone Outlet:

1. Products:
   a. Leviton; 40649.
   b. Cooper; 3560-6.
   c. Or, Equal

2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

B. Combination TV and Telephone Outlet:

1. Products:
   a. Leviton; 40595.
   b. Cooper; 3562.
   c. Or, Equal
2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.11 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Color to match.
   2. Standard size cover plates, not oversized.
   3. Material for Damp Locations: Cast metal with spring-loaded lift cover, and listed and labeled for use in wet locations.

B. Wet-Location, Weatherproof In-Use Cover Plates: NEMA 250, complying with type 3R weather-resistant in-use cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordination with Other Work:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install wiring devices after all wall preparation, including painting, is complete.

B. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

C. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

D. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

E. Cover plates
   1. Provide cover plates of the same size throughout the project.

3.2 IDENTIFICATION

A. Comply with Section 260553 Identification.

B. Label device cover plates per source and circuit.

3.3 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.

   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.

   3. Ground Impedance: Values of up to 2 ohms are acceptable.

   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
      a. Nuisance trip test: Verify that a current, below 4 milliamperes (mA), will not cause the GFCI to trip. A passing GFCI receptacle will not trip below 4 mA, it should trip with a reading between 4-6 mA.
      b. Safety check test: Verify that a current of between 4-6 mA will trip the GFCI. The device passes when it trips between 4-6 mA.
      c. Radio Transmitter Test: In critical applications, a typical site radio transmitter shall be keyed in proximity, 1 foot (300mm), of the GFCI device to verify that it is immune to a nuisance trip.
      d. Critical GFCI devices shall be identified on the record drawings.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION
SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Cartridge fuses rated 600 V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.

1.2 RELATED SECTIONS

A. Section 260553 Identification
B. Section 262413 Switchboards
C. Section 262416 Panelboards
D. Section 262816 Enclosed Switches & Circuit Breakers

1.3 DEFINITIONS

A. NEMA: National Electrical Manufacturer’s Association

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.
B. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer’s technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer’s technical data on features, performance, electrical characteristics, and ratings.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   5. Coordination charts and tables and related data.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 standards for cartridge fuses.


1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 degrees Fahrenheit (5 degrees Centigrade) or more than 100 degree Fahrenheit (38 degrees Centigrade), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.8 EXTRA MATERIALS

A. Provide extra materials that match products provided and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of the required quantity for each size and type, but no fewer than 3 of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
   3. Or equal

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before placement. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and product instructions. Apply fuses of sizes and with characteristics appropriate for each piece of equipment.
D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with assembly only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Motor Branch Circuits: Class RK5, time delay.
   2. Control Circuits: Class CC, fast acting.

3.3 FUSES

A. Assemble fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Apply labels complying with requirements for identification specified in Section 260553 Identification and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION
SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SCOPE

A. Section Includes:
   1. Fusible switches
   2. Molded-case circuit breakers (MCCBs)
   3. Enclosures

1.2 RELATED SECTIONS

A. Section 260519 Conductors and Cables
B. Section 260548 Vibration and Seismic Controls
C. Section 260553 Identification
D. Section 262813 Fuses

1.3 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. DPST: Double pole, single throw.
D. NRTL: Nationally Recognized Testing Laboratory
E. NEMA KS 1: National Electrical Manufacturers Association standards for enclosed switches
F. NEMA 250: National Electrical Manufacturers Association standards for electrical enclosures
H. CEC: California Electrical Code.

1.4 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.

B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
C. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified Operation and Maintenance Data, include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.


1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 degrees Fahrenheit and not exceeding 122 degrees Fahrenheit.
   2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and placement of switches, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Provide extra materials that match products provided and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Refer to Section 262813 Fuses for required spares.
   2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Or equal

B. Type HD, Heavy Duty, Single Throw, for both 240 and 600 V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
   2. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 MOLDED-CASE CIRCUIT BREAKERS
A. Enclosed molded case circuit breakers are not used in this project.

2.3 ENCLOSURES
A. Enclosed Switches: NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at applied location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   2. Wash-Down Areas: NEMA 250, Type 4X.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X.

B. Enclosure shall be lockable in the off position.

C. Provide defeater mechanism to bypass door lock out when the operating handle is in the on position

PART 3 - EXECUTION
3.1 EXAMINATION
A. Examine elements and surfaces to receive enclosed switches for compliance with tolerances and other conditions affecting performance of the Work.

B. Proceed with Work only after unsatisfactory conditions have been corrected.

3.2 ENCLOSED SWITCHES AND CIRCUIT BREAKERS
A. Provide individual wall-mounted switches with tops at uniform height unless otherwise indicated.

B. Comply with requirements specified in Section 260548 Vibration and Seismic Controls.

C. Provide fuses in fusible devices.
D. Provide with auxiliary contacts when disconnect is located between a variable frequency drive and a motor. Provide ½-inch conduit and 2#12 conductor from the auxiliary contacts in the disconnect to the variable frequency drive to indicate open switch.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 Identification.
   1. Identify conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.
   3. Provide label to indicate source per CEC 408.4.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site. Retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report identifying enclosed switches, circuit breakers and test results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION
SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:
   1. Full-voltage manual.
   2. Full-voltage magnetic.
   3. Reduced-voltage magnetic.
   4. Reduced-voltage solid state.
   5. Multispeed.

1.3 DEFINITIONS

A. CPT: Control power transformer.
B. MCCB: Molded-case circuit breaker.
C. MCP: Motor circuit protector.
D. N.C.: Normally closed.
E. N.O.: Normally open.
F. OCPD: Overcurrent protective device.
G. CEC: California Electrical Code
H. NRTL: Nationally Recognized Testing Laboratory
I. NEMA KS 1: National Electrical Manufacturers Association standards for enclosed switches
J. NEMA 250: National Electrical Manufacturers Association standards for electrical enclosures

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
1. Show tabulations of the following:
   a. Each installed unit's type and details.
   b. Factory-installed devices.
   c. Nameplate legends.
   d. Short-circuit current rating of integrated unit.
   e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
   f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

E. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for enclosed controllers and installed components.
   2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
   3. Manufacturer's written instructions for setting field-adjustable overload relays.

F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by District or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify District’s Representative no fewer than ten days in advance of proposed interruption of electrical systems.

2. Indicate method of providing temporary utilities.

3. Do not proceed with interruption of electrical systems without District Representative’s written permission.

4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Indicating Lights: Two of each type and color installed.

4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.

5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

1. Basis-of-Design Product: Subject to compliance with requirements listed on drawings, provide product indicated on Drawings by General Electric or comparable product by one of the following:

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

b. Rockwell Automation, Inc.; Allen-Bradley brand.

c. Siemens Energy & Automation, Inc.

d. Square D; a brand of Schneider Electric.
e. Or, Equal.

2. Configuration: Nonreversing.

   a. Operating Voltage: 120 volt control power.

4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 100 VA.

6. Solid-State Overload Relay:
   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

7. (1) N.C and (1) N.O., isolated overload alarm contact.

8. External overload reset push button.

9. Fusible Disconnecting Means:
   a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 4.
   3. Wet or Damp Indoor Locations: Type 4.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
      a. Push Buttons: Shrouded types; momentary as indicated.
      b. Pilot Lights: LED types; colors as indicated; push to test.
   2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.

B. (2) N.C. and (2) N.O. auxiliary contact(s).
C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 type enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Spare control wiring terminal blocks, quantity as indicated wired for 12 points.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Install fuses in each fusible-switch enclosed controller.

D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.
   4. Provide label to indicate source per CEC 408.4.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.
1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify The District’s Representative before starting the motor(s).
   5. Test each motor for proper phase rotation.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed controllers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION
SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SCOPE

A. Section Includes:
   1. General requirements for lighting fixtures & components.
   2. Emergency lighting units.
   3. Exit signs.
   4. LED Luminaire
   5. Lighting fixture supports.

1.2 RELATED SECTIONS

A. Section 26 05 19 Conductors and Cables
B. Section 26 05 23 Control Voltage Electrical Power Cables
C. Section 26 05 29 Hangers and Supports
D. Section 26 09 23 Lighting Control Devices

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI C82.1 Specification for Fluorescent Lamp Ballasts.
   2. ANSI 82.2 Fluorescent Lamp Ballasts, Method of Measurement.

B. Underwriters Laboratories, Inc. (UL):
   1. UL 66 Fixture Wire.
   2. UL 542 Standard for Fluorescent Lamp Starters.
   4. UL 935 Standard for Fluorescent-Lamp Ballasts.
   5. UL 1598 Luminaires.

C. Illuminating Engineering Society of North America (IESNA):
1.4 SYSTEM DESCRIPTION

A. Provide a fully functioning and operational lighting system as described herein complete with lamps, ballasts, drivers, wiring, controls and attachment to support system adhering to applicable seismic code requirements.

1.5 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. LER: Luminaire efficacy rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.6 SUBMITTALS

A. Submit in accordance with Section 01 33 23 Shop Drawings, Product Data, and Samples

B. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Sway adapters, seismic restraint devices and detailed method of mounting.
   3. A sample of the hanger assembly for suspended luminaires shall be supplied to the University’s Representative for review and approval.
   4. Emergency lighting units including battery and charger.
   5. Ballast, including BF.
   7. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."

     8. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

     9. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

        a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

D. Field quality-control reports.
E. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

B. Warranty: See Article 1.11 Warranty.

1.8 MATERIALS MAINTENANCE SUBMITTALS

A. Provide extra materials that match products utilized and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 of each type and rating utilized. Provide at least one of each type.
   2. Plastic Diffusers and Lenses: One for every 100 of each type and rating utilized. Provide at least one of each type.
   3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20 emergency lighting units utilized.
   4. Ballasts: One for every 100 of each type and rating utilized. Provide at least one of each type.
   5. Globes and Guards: One for every 20 of each type and rating utilized. Provide at least one of each type.

1.9 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.10 COORDINATION

A. Prior to rough-in of fixtures, consult the University's Representative drawings for details of ceiling construction, finish, reflected ceiling plans and other applicable details and coordinate layout of lighting fixtures and suspension system. Field coordinate other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.11 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace
components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 5 years from date of Notice of Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years. Labor shall be included for the duration of the Warranty at no additional expense to the University.

2. Warranty Period for Emergency Fluorescent Ballast Batteries: 5 years from date of Notice of Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years. Labor shall be included for the duration of the Warranty at no additional expense to the University.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Provide product indicated on Drawings or Equal.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-provided infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-provided electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

3. Master/Remote Sign Configurations:
   a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
   b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.4 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924 and California Title 20.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire guard in first subparagraph below is optional feature. Coordinate with Drawings.
7. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
8. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
9. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-provided infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
10. Integral Self-Test: Factory-provided electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 LED LUMINAIRE

A. Light Emitting Diodes (LED):
   1. Refer to the Luminaire Schedule for size and type of LEDs required.
   2. All diodes shall be of the same manufacturer and bin number.
   3. Diodes shall be tested and tuned for the specified Kelvin color.
   4. Color correlated temperature: 4000K within a 4-step MacAdam ellipse unless otherwise noted in the drawings.
   5. Minimum CRI (Color Rendering Index): 90
   6. LED luminaire shall be free of toxic materials and be RoHS compliant.
   7. Groups of three or more diodes in a single housing shall be tested for even distribution.
   8. Standard lumen output shall meet or exceed the State of California Title 24 Energy Code for high efficiency luminaires.
   9. LED luminaires shall have an IES formatted electronic photometrics report.
   10. Diodes shall have a minimum life of 50,000 hours and maintain at least 80 percent of initial lamp lumens during this period.
   11. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
   12. LED boards shall be suitable for field maintenance or service from below the ceiling with plug-in connectors. LED boards shall be upgradable.
   13. Color shift over 6,000 hours shall be <0.007 change in u’ v’ as demonstrated in IES LM80 report.

B. Power Supply and Driver:
   1. Drivers shall be integral to fixture housing.
   2. Drivers shall have a ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
   3. Drivers shall be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that do not meet these requirements will not be accepted.
   4. Electrical characteristics: 120 – 277 Volt, > 0.9 power factor, UL Listed, CSA Certified, Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.
   5. Dimming: Driver shall be suitable for full-range dimming. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100 percent to 10 percent (1 percent where specified) of rated lumen output with a smooth shut off function.
   6. Dimming quality to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transition), natural square law response to control input, inaudible in 26db environment,
and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.

a. Dimming shall be controlled by a 0-10V signal

b. Driver shall include ability to provide no light output when the analog control signal drops below 0.5V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 Watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

c. Driver shall be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels.

d. Driver must be capable of 20 bit dimming resolution for white light LED driver.

e. Drivers shall track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.

7. Flicker: Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100 – 0.1 percent luminaire shall have:

8. Less than 1 percent flicker index at frequencies below 120Hz.

9. Less than 12 percent flicker index at 120Hz, and shall not increase greater than 0.1 percent per Hz to a maximum of 80 percent flicker index at 800Hz.

10. Driver disconnect shall be provided where required to comply with codes.

11. The electronics/power supply enclosure shall be internal to the solid state lighting luminaire and be accessible per UL requirements.

12. The surge protection which resides within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 2002 for Location Category A, where failure does not mean a momentary loss of light during the transient event.

C. Electrical:

1. Operation Voltage: The luminaire shall operate from a 50 or 60Hz +/- 3Hz AC line over a voltage ranging from 120VAC to 277VAC. The fluctuations of line voltage shall have no visible effect on the luminous output. The standard operating voltages are 120VAC, 277VAC & 347VAC.

2. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

3. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.

4. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference. Withstand up to a 1,000 Volt surge without impairment of performance as defined by ANSI C62.41 Category A.
5. Inrush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps.

6. RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions.

7. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
   a. Adjustment of forward LED voltage, supporting 3V through 60V.
   b. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA.
   c. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

8. Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be replaceable without removing the fixture from the ceiling.

9. All electrical components shall be RoHS compliant.

D. Photometric Requirements:
   1. Luminaire performance shall be tested as described herein.
      a. Luminaire performance shall be judged against the specified minimum illuminance in the specified pattern for a particular application.
      b. Luminaire lighting performance shall be adjusted (depreciated) for the minimum life expectancy.
      c. The performance shall be adjusted (depreciated) by using the LED manufacturer's data or the data from the IESNA Standard TM-21 test report, which ever one results in higher level of lumen depreciation.
      d. The luminaire may be determined to be compliant photometrically, if:
         1) The initial minimum illuminance level is achieved in 100% of the area of the specified lighting pattern.
         2) The measurements shall be calibrated to standard photopic calibrations.

E. Thermal Management:
   1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
   2. The LED manufacturer’s maximum junction temperature for the expected life shall not be exceeded at the average operating ambient.
   3. The LED manufacturer’s maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.
   4. The luminaire shall have an UL IC rating.
   5. The driver manufacturer’s maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 26 05 29 Hangers and Supports for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.


E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 PLACEMENT

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Provide lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by University’s Representative, to use permanent luminaires for temporary lighting, provide and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, and provide new lamps.

C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
   1. Provide ceiling support system rods or wires, independent of the ceiling suspension devices for each fixture. Locate not more than 6 inches from lighting fixture corners.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Provide as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
   4. Provide at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

D. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   2. Suspended luminaires shall be provided such that they are able to swing 45 degrees from vertical in all directions unobstructed.
4. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

5. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

6. Connect wiring according to Section 26 05 23 Low-Voltage Electrical Power Conductors and Cables.

3.2 IDENTIFICATION

A. Provide labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 05 53 Identification.

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

C. LED luminaires will be considered faulty and require replacement if one or more diodes are not functioning.

3.4 STARTUP SERVICE

A. Burn-in all LED lamps that require specific aging period to operate properly, prior to occupancy by University.

3.5 ADJUSTING

A. Occupancy Adjustments: Within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of University's Representative.

END OF SECTION
SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior luminaires.
   2. Lamps and diodes.
   3. LED drivers.
   4. Luminaire-mounted motion sensors.
   5. Poles and pole mount accessories.

1.2 RELATED SECTIONS

A. Section 260519 Conductors and Cables
B. Section 260523 Control Voltage Electrical Power Cables
C. Section 260529 Hangers and Supports
D. Section 260923 Lighting Control Devices

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI C78.377A Chromaticity.

B. Underwriters Laboratories, Inc. (UL):
   1. UL 66  Fixture Wire.
   2. UL 1598  Luminaires.
   3. UL 2108  Standard for Low Voltage Lighting Systems.

C. Illuminating Engineering Society of North America (IESNA):
   3. IESNA TM-21-2011 Projecting Long Term Lumen Maintenance of LED Light Sources

1.4 SYSTEM DESCRIPTION

A. Provide and install a fully functioning and operational lighting system as described herein complete with lamps, ballasts, drivers, wiring, controls and attachment to support system adhering to applicable seismic code requirements.
1.5 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color-rendering index.
C. LER: Luminaire efficacy rating.
D. Luminaire: Complete lighting fixture, including ballast housing if provided.
E. Pole: Luminaire support structure, including tower used for large area illumination.
F. Standard: Same definition as "Pole" above.

1.6 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaires and accessories.
   3. Details of installation and construction.
   4. Luminaire materials.
   5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
      b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   7. Ballasts and drivers, including energy-efficiency data.
   8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
   9. LED luminaire data shall be consistent with the LED Lighting Facts program or Designlights Consortium (DLC) guidelines.
10. Luminaire dimming controlled by motion detection.
11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

B. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that
load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

C. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

D. Field quality-control reports.

E. Operation and Maintenance Data: For luminaires and poles to include in operation and maintenance manuals.

F. Warranty: Sample of special warranty.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers’ laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.


E. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.

D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
1. Warranty Period for Luminaires: Two years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Glass and Plastic Lenses, Covers, and Other Optical Parts: Furnish at least one of each type.
2. Ballasts/Drivers: Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Product(s) indicated on Drawings or equal.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
1. LER Tests Fluorescent luminaires: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
2. LER Tests for LED luminaires: Test and measurement in accordance with IESNA LM-79; Lumen Maintenance in accordance with IESNA LM-80.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
I. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

J. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

K. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As selected from manufacturer's standard catalog of colors.

   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
   4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
      a. Color: As specified on drawings.

M. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.3 LIGHT EMITTING DIODES (LED)

A. Refer to the Luminaire Schedule for size and type of LED lamps required.
   1. All diodes shall be of the same manufacturer and bin number in adherence to current NEMA standard SSL-3.
   2. Diodes shall be tested and tuned for the specified Kelvin color.
   3. Color correlated temperature: 4000K unless otherwise noted in the drawings.
   4. Minimum CRI (Color Rendering Index): 80
   5. LED luminaire shall be free of toxic materials and be RoHS compliant.
6. Groups of three or more diodes in a single housing shall be tested for even distribution.
7. Standard lumen output shall meet or exceed the State of California Title 24 Energy Code for high efficiency luminaires.
8. LED luminaires shall have an IES formatted electronic photometrics report.
9. Diodes or Solid State LED chips shall have a minimum life of 50,000 hours and maintain at least 70% of initial lamp lumens during this period.

2.4 LED DRIVERS
A. Drivers shall be integral to fixture housing unless otherwise directed.
B. Drivers shall have a minimum life of 50,000 hours and maintain at least 70% of initial lamp lumens during that period.
C. Dimming applications, provide Dimmable Constant Current Drivers:
   1. Wattage shall be as specified on the luminaire schedule and operate at 700mA unless otherwise noted on the luminaire schedule.
   2. Dimmable to 30%.
   3. Minimum efficiency to be 89%.
   4. Ingress Protection (IP67) rated.
   5. Minimum warranty of 5 years.
   6. Universal voltage.
D. Non-dimming applications, provide Constant Voltage LED Drivers:
   1. Capable of 12 volt or 24 volt output.
   2. Minimum efficiency to be 93%.
   3. Ingress Protection (IP67) rated.
   4. Minimum warranty of 5 years.
   5. Universal voltage.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS
A. Structural Characteristics: Comply with AASHTO LTS-4-M.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.6 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.
   1. Shape: Round, straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

G. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

H. Prime-Coat Finish: Manufacturer’s standard prime-coat finish ready for field painting.
I. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

J. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
   3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As specified on drawings.

2.7 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE PLACEMENT

A. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

B. Adjust luminaires that require field adjustment or aiming.

3.2 POLE PLACEMENT

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, placement, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRIES

A. Place concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."
3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceway and Boxes." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding."
   1. Provide grounding electrode for each pole unless otherwise indicated.
   2. Provide grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding."
   1. Provide grounding electrode for each pole.
   2. Provide grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.6 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Label new luminaires with code identified on the drawings. Methods shall match existing method used on campus.

C. Illumination Observations: Verify normal operation of lighting units after providing luminaires and energizing circuits with normal power source.
   1. Verify operation of motion sensor controlled luminaires. Dimming and fade rate are initiated by the motion sensor. The reduction in lumen output shall report to the campus lighting control system.
   2. Confirm that two-way communication between luminaire RF control unit and campus lighting control system is accomplished.

D. LED luminaires will be considered faulty and require replacement if one or more diodes are not functioning.

E. Illumination Tests:
   1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
      c. IESNA LM-64, "Photometric Measurements of Parking Areas."
      d. IESNA LM-72, "Directional Positioning of Photometric Data."
F. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION
DIVISION 27
COMMUNICATIONS
SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and 26 Specification Sections, apply to this Section.

B. Section 078400 Firestopping

1.2 SUMMARY

A. Section Includes:
   1. Communications equipment coordination and work.
   2. Sleeves for pathways and cables.
   3. Sleeve seals.
   5. Common communications work requirements.

1.3 DESCRIPTION

A. Provide and test for a complete and functional tel/data communications system to provide voice and data communications. Include all material to form a complete system.

B. Provide J-hooks, boxes and supporting hardware as required to provide complete pathway systems.

C. Provide station cabling, faceplates and jacks for connectivity of voice and data systems.

D. Provide racks, wireways, wire management, continuous equipment grounding to bus bars, hardware and accessories required for a complete, fully configured voice and data communications system.

E. Test and label all tel/data communications cabling, provide completed test documentation illustrating values consistent with BICSI recommendations and include with electronic copy of the record drawings.

1.4 QUALITY ASSURANCE

A. The communications system company specializing in tel/data communication cabling installation shall have a documented minimum of five years in the structured cabling business and experience with projects similar to this project. References are required.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of tel/data communications equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.

4. So connecting pathways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for tel/data communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 078400 Firestopping.

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, galvanized steel, plain ends.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 GROUT

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

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange components and equipment to provide maximum possible headroom consistent with these requirements.

C. Equipment: Work to facilitate service, maintenance, and repair or replacement of components of both tel/data communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
D. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Provide sleeves for penetrations unless core-drilled holes or formed openings are used. Accommodate sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Provide sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves thru floors 6 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Underground, Exterior-Wall Penetrations: Provide cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for mechanical sleeve seals.

END OF SECTION
SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tel/data communications mounting elements.
      a. Backboards
      b. Tel/data communications equipment racks and cabinets.
      c. Tel/data communications service entrance pathways.
      e. Grounding.

B. Provide a complete Tel/data communications System, with including all wiring and connections and other materials referenced on Plans and specified herein. It is intended that a complete operating system be provided including power supplies, line cards, control cards, interface cards, programming, or other items required to achieve this end result shall be provided whether or not such item or items are specified herein or shown on Plans.

C. Tel/data communication systems supplier shall meet with District's Representative and the District's telephone system provider to coordinate telephone system configuration prior to expansion of systems.

1.2 RELATED DOCUMENTS

A. Section 061000 Rough Carpentry
B. Section 078400 Firestopping
C. Section 099100 Painting
D. Section 260526 Grounding and Bonding
E. Section 260533 Raceway and Boxes
F. Section 260553 Identification
G. Section 271300 Communications Backbone Cabling
H. Section 271500 Communications Horizontal Cabling
I. Section 280513 Conductors and Cables for Electronic Safety and Security

1.3 DEFINITIONS

A. ASTM International: American Society for Testing and Materials
B. ANSI: American National Standards Institute
C. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.


E. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches (152 mm) in width.

F. BDR/FDR: Building Distributor Room/Floor Distributor Room.

G. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

H. EMI: Electromagnetic interference.

I. IDC: Insulation displacement connector.

J. IEEE: Institute of Electrical Electronic Engineers

K. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

L. LAN: Local area network.

M. RCDD: Registered Communications Distribution Designer.

N. UTP: Unshielded twisted pair.

O. UL. Underwriter's Laboratory

P. TIA/EIA. Telecommunications Industry Association cabling standards

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and provided specialties and accessories. Product data shall be accompanied by Shop Drawings. Product Data submitted without Shop Drawings will be considered incomplete and therefore rejected.

C. Provide two cross reference lists: (1) items of equipment with specified system function each item provides, and (2) specified system function with item of equipment which performs that function. Contractor shall also submit name of firms he proposes to do work under this Section, addresses, phone numbers, and name of firm's contact, for approval. Such firms shall be factory authorized representatives of the equipment specified, who shall provide all equipment, make all connections to same, and place the systems in operation. Such firms
shall have offices and service departments within a 50-mile radius of project and shall have been in business of this type for at least five years.

D. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work. Building plans shall be 1/8-inch =1 foot-0 inches, and site plans shall be no smaller than 1 inch = 40 feet.

1. Submittal shall show elevations of terminal backboards with equipment laid out.

E. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

F. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

G. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

H. Qualification Data: For Contractor, qualified layout technician, supervisor, and field inspector.

I. In order to qualify for the providing of the tel/data communications system, the Contractor must possess the required license classification, trade certifications, a performance history, experience in the provision and termination of fiber optics cable systems, and proof of time in business.

J. License Classification: Contractor must possess a valid C-7 California State Contractor's License. This license must have been issued two years prior to the date of this bid. No other license classification is acceptable.

K. BICSI Certifications: Contractor shall employ use of personnel certified by the trade organization BICSI for this project. The vendor must have a Registered Communications Distribution Designed (RCDD®) on staff who will be ultimately responsible for this project. The RCDD must have sufficient experience in this type project as to be able to lend adequate technical support to the field forces, the duration of the warranty period and during any extended warranty periods or maintenance contracts. The customer must attach a resume of the responsible RCDD to the vendor's response for evaluation. Should the RCDD assigned to this project change during the execution of work; the new RCDD assigned must also submit a resume for review by the customer. The Contractor must also have BICSI registered technicians on staff and assign them to this project. The project shall be staffed at all times by technicians who, in the role of lead craftsperson, will be able to provide leadership and technical resources for the remaining crafts persons on the project. A minimum of 30 percent of personnel shall be BICSI registered communications technicians.

L. Performance History: Contractor must have successfully performed at least three projects of similar scope, within two years of the date of this bid. Proof of performance shall be in the form of reference sheets which shall include a brief description of the project, the beginning and ending contract price, the project foreman or superintendent’s name, and the name, address, and telephone number of a project contact.

M. Fiber Optics Experience: Contractor must be able to prove to the satisfaction of District's Representative that they have had significant experience in the provision of fiber optics cable systems. Experience must include placement of fiber optics cable, fiber termination, a knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
Contractor must provide a minimum of three (3) references supporting its claim of experience for similar projects within the two years prior to this bid. Documentation must be included with the bid documents submitted.

N. Time In Business: contractor must have been in business, and in the business of providing tel/data communications systems continuously, for a period of at least three years, prior to the date of this bid. Contractor must submit at least one project reference for each of the three years prior to the date of this bid. The Contractor must also maintain a full time staff at an established business location having appropriate parts and service facilities and the ability to provide a one-hour response time to this campus. Any Contractor unable to meet these requirements will not be considered as an acceptable contractor for this project.

O. System Requirements: All of various equipment components to be complete with all appurtenant accessories required to provide specified facilities and perform specified functions throughout presently planned construction and space; and provisions for expanding system to provide same facilities, and perform same functions in all future planned construction, including space and mountings in racks and on terminal backboards.

P. Seismic Qualification Certificates: For floor-mounted cabinets, accessories, and components, from manufacturer.

Q. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

R. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.

S. Detailed description of equipment anchorage devices on which the certification is based and their requirements.

1.6 QUALITY ASSURANCE

A. Contractor Qualifications: Contractor must have personnel certified by BICSI on staff.

B. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.

C. Supervision: Work shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

D. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Tel/data communications Pathways and Spaces: Comply with TIA/EIA-569-A.


1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or provide equipment frames and cable trays until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and work above ceilings is complete.
1.8 COORDINATION

A. Coordinate layout of system communications equipment with District's Representative for the tel/data communications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with tel/data communications and LAN equipment suppliers, local exchange carrier representatives, and District to exchange information and agree on details of equipment arrangements and interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.

2. Support brackets with cable tie slots for fastening cable ties to brackets.

3. Lacing bars, spools, J-hooks, and D-rings.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cable Management Solutions, Inc.
   b. Cablofil Inc.
   c. Cooper B-Line, Inc.
   d. Cope - Tyco/Allied Tube & Conduit.
   e. GS Metals Corp.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick.
   a. Basket Cable Trays: 6 inches wide and 2 inches deep. Wire mesh spacing shall not exceed 2 by 4 inches.
   b. Trough Cable Trays: Nominally 4 inches by 18 inches wide
c. Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches on center.

d. Channel Cable Trays: One-piece construction, 4 inches wide. Slot spacing shall not exceed 4-1/2 inches on center.

D. Conduit and Boxes: Comply with requirements in Section 260533 Raceway and Boxes. Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 4 11/16 inches square and 2-1/2 inches deep.

2.2 SYSTEM FUNCTIONS AND OPERATIONS

A. The tel/data communications system is existing and shall be modified to accommodate this scope of work. Include all items of hardware, expansion cards, programming and commissioning for a complete and operable system.

B. Include testing and satisfactorily perform demonstration of operability in the presence of the District's Representative. Make corrections necessary prior to sign-off.

C. Confirm equipment and quantities with District prior to submitting bid.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 Rough Carpentry.

2.4 EQUIPMENT FRAMES (IDF)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ADC.
2. Aim Electronics; a brand of Emerson Electric Co.
3. AMP; a Tyco International Ltd. company.
4. Cooper B-Line, Inc.
5. Hubbell Premise Wiring.
6. KRONE Incorporated.
7. Leviton Voice & Data Division.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Ortronics, Inc.
10. Panduit Corp.
11. Siemon Co. (The).
12. Or, Equal.

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for tel/data communications terminal support and coordinated with dimensions of units to be supported.


3. Finish: Manufacturer's standard, baked-polyester powder coat.
C. Floor-Mounted Racks: Modular-type, 11 gauge alloy steel construction.
   1. Vertical and horizontal cable management channels, top and bottom cable troughs, 
      grounding lug, and a power strip with six outlets.
   2. Baked-polyester powder coat finish.

D. Modular Wall Cabinets:
   1. Wall mounting.
   2. Steel construction.
   3. Treated to resist corrosion.
   4. Lockable front doors.
   5. Louvered side panels.
   6. Cable access provisions top and bottom.
   7. 500 VA rack mounted UPS, Tripp-Lite or equal.
   8. Grounding lug.
   11. All cabinets keyed alike.

E. Cable Management for Equipment Frames:
   1. Metal, with integral wire retaining fingers.
   2. Baked-polyester powder coat finish.
   3. Vertical cable management panels shall have front and rear channels, with covers.
   4. Provide horizontal crossover cable manager at the top of each relay rack, with a 
      minimum height of two rack units each.

2.5 POWER STRIPS

A. Power Strips: Comply with UL 1363.
   1. Rack mounting type.
   2. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
   3. LED indicator lights for power and protection status.
   4. LED indicator lights for reverse polarity and open outlet ground.
   5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot 
      be reset.
   7. Rocker-type on-off switch, illuminated when in on position.
   9. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 
      clamping voltage for all 3 modes shall be not more than 330 V.

2.6 WIRELESS ACCESS POINTS (WAP)

A. Manufacturers: Cisco Aironet 3600 Series Access Point, or approved equal.
B. Compatibility: 4X4 MIMO, IEEE 802.11a/g and legacy District’s IEEE 802.11b wireless clients with selection of three radio modes of operation: IEEE 802.11n, 802.11a, or 802.11g with fallback support for 802.11b.


D. Power: 120 VAC source required. Provide duplex receptacle adjacent to each WAP location. Alternately, it will be acceptable to deploy as PoE and will require an Ethernet switch at the IDF.

2.7 GROUNDING

A. Comply with requirements in Section 260526 Grounding and Bonding for grounding conductors and connectors.

1. Tel/data communications Main Bus Bar:
   a. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
   b. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide by 18 inches long with 9/32-inch holes spaced 1-1/8 inches apart.
   c. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.8 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 WORK REQUIREMENTS

A. Contractor shall retain the services of the duly appointed representative as specified here in before, who shall provide all equipment, make all connections to same, and place system in operation. Technician and workman employed shall be particularly skilled in this type of work and certified by the Telephone System Manufacturer. Workmanship shall be of professional quality and best commercial practice.

B. Provide necessary programming. Confirm operational requirements of system with the District's Representative. Include all items of programming and operational requirements in the Operations and Maintenance Manual.

C. All wiring throughout entire system shall be provided in conformance with standard telephone company practice. Each terminal backboard shall be provided with terminations as follows:

1. Terminal blocks shall be AT&T 110AB1-100FT - Comcode 103 823 845 or AT&T 110AB1-300FT - Comcode 104 049 051.

2. Provide same quantity of block terminals as phones and modems indicated on plans, plus a minimum of 25 percent spare.
D. Wiring Blocks: Wiring blocks shall be mounted on telephone terminal backboard and oriented as intended by manufacturer. Mount each device such that its horizontal and vertical dimensions are level. Device shall be affixed by means of four screws suitable for fastening to the backboard. Screws shall be tightened to the extent that they hold the device snug to the backboard, but not so tight as to distort or damage device. Provide in accordance with manufacturer's instructions and recommendations.

E. Provide required interfaces, connections, wiring, and components to other systems and or devices requiring telephone system interface or service, including, but not limited to:

1. Intrusion Alarm System.
2. Fire Alarm System.
3. Intercom Communications System.

F. Cables shall be run through fanning strip to terminals of terminal blocks. All conductors shall be "punched" down on terminals.

G. Cables on backboards or within terminal cabinets shall be bound with plastic cable ties so that cables are in tight contact for their entire length.

H. Cables entering on to backboard or into terminal cabinet shall be identified with Panduit SSM4S-C or PLF/MA-C marker tie flags. Upon completing the execution of work, six copies of one-line "as-built" wiring diagram shall be provided to District's Representative.

I. Each cable run on wiring diagram shall be identified with exact wire marker code (numerical or alphabetical) as appears on backboard or in terminal cabinet.

J. Station locations shall be identified by location and room numbers and in all ways shall relate as closely as possible to record wiring drawings. Prior to performing final labeling, coordinate label information with District’s Representative.

K. No splices shall occur in underground pull boxes. Telephone system wiring shall be continuous, without splices, from backboard to backboard or cabinet and from backboard or cabinet to devices. All interior pull boxes shall be accessible and locations shall be recorded on "As-Built" drawings.

3.2 CONSTRUCTION MEETINGS

A. The Contractor shall schedule construction meetings at the jobsite as follows:

B. Prewire meeting shall occur after raceways are applied and prior to pulling of any wire or cable. Invite the District IT representative to this meeting to confirm requirements of equipment locations, network access points, network nodes for EMS and Network Lighting Controls system are addressed.

C. Pre-termination meeting shall occur after wire and cable work is complete and prior to termination.

D. Meetings shall be scheduled by the Contractor on a building-by-building basis and shall include the Project Inspector, District’s Representative, the electrical subcontractor, and the Telephone System provider as a minimum.

3.3 ENTRANCE FACILITIES

B. Provide underground entrance pathway complying with Section 260533 Raceway and Boxes.

C. Comply with BICSI TDMM for layout and application of communications equipment rooms.

D. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

E. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide lacing bars and distribution spools.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078400 Firestopping. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Provide grounding system according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to electrical ground bus in building distribution panel.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

E. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 260553 Identification for Electrical Systems. Comply with requirements in Section 099100 Interior Painting for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Section 271500 Communications Horizontal Cabling for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration including optional identification requirements of this standard.

C. Labels shall be preprinted or computer-printed type.

3.7 RECORD DRAWINGS
A. Refer to General Conditions. Final Inspection will not be made until drawings are received and approved. Record Drawings shall include "As-Built" one-line and wiring diagrams, with terminations identified, wire color-coding schedule, pull box locations, and conduit routing plans.

3.8 GUARANTEE

A. One firm to assume full responsibility for performance on all work of this section. Guarantee all equipment against defects in material and workmanship for one (1) year, and provide on-the-premises service during normal working hours for three years, at no cost to purchaser if trouble is not caused by misuse, abuse, or accident, or at current labor rates if so caused. Provide manufacturer's written guarantee for equipment and parts to District's Representative.

B. Service shall normally be available within 24 hours from service department of authorized distributor of manufacturer by factory-trained servicemen.

C. On-the-premises service at other than normal working hours to also be available, but labor charges for such calls to be paid by purchaser at current labor rates.

3.9 TESTS

A. After all equipment specified and associated work herein has been provided and is in operating condition, performance tests shall be conducted to determine that system and components comply with these specifications. Contractor shall provide competent personnel for these tests.

B. Testing shall be scheduled with the District's Representative and shall occur after receipt by District of Contractor's written certification of completion, record one-line diagram, wiring diagrams, maintenance and operation manuals, and other "As-Built" data required by these specifications. Tests shall be scheduled with District before occupancy occurs.

END OF SECTION 27 11 00
SECTION 27 13 00

COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SCOPE

A. Section Includes:
   1. Pathways.
   2. UTP cable.
   3. 50/125-micrometer, optical fiber cabling.
   5. Cable connecting hardware, patch panels, and cross-connects.

1.2 RELATED SECTIONS:

A. Section 078400 Firestopping
B. Section 099100 Painting
C. Section 260526 Grounding and Bonding
D. Section 260533 Raceway and Boxes
E. Section 260553 Identification
F. Section 271100 Communication Equipment Rooms

1.3 DEFINITIONS

B. BDR/FDR: Building Distributor Room/Floor Distributor Room.
C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
D. EMI: Electromagnetic interference.
E. IDC: Insulation displacement connector.
F. LAN: Local area network.
G. RCDD: Registered Communications Distribution Designer.
H. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION
A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the tel/data communications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms, at entrance facilities and electric rooms. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Submit in accordance with Section 013323 Shop Drawings, Product Data and Samples.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format compliant with District’s methods. Field coordinate with District’s Representative and provide to their satisfaction.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics including the following:
      b. Patch panels.
      c. Patch cords.
   4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the provided components.
   5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer’s rating for tray and its support elements.

C. Qualification Data: For Contractor, qualified layout technician, supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Print out of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Contractor Qualifications: Contractor must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, and field testing program development by an RCDD.
   2. Supervision: Work shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.
   1. Testing Agency’s Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Tel/data communications Pathways and Spaces: Comply with TIA/EIA-569-A.


1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not provide cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
1.10 COORDINATION

A. Coordinate layout and placement of tel/data communications pathways and cabling with District’s tel/data communications and LAN equipment and service suppliers.

1.11 EXTRA MATERIALS

A. Provide extra materials that match products provided and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Patch-Panel Units: One of each type.
   2. Connecting Blocks: One of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6A cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

C. Cable Trays:
   1. Refer to Section 271100 Communication Equipment Rooms for requirements.

D. Conduit and Boxes: Comply with requirements in Section 260533 Raceway and Boxes. Flexible metal conduit shall not be used.
   1. Outlet boxes shall be no smaller than 4-11/16 inches square and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Refer to Section 271100 Communications Equipment Rooms for requirements.

2.3 UTP CABLE

A. Manufacturers:
   1. Berk-Tek.
   2. Panduit.
   3. SYSTIMAX Solutions; a CommScope Inc. brand.
   4. ACD/Krone.
   5. Siemon.
   6. Or, Equal.

B. Description: 100-ohm, 25-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.
   1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.


4. 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, Riser Rated: Type CMR.
   c. Communications, Limited Purpose: Type CMX.
   d. Multipurpose: Type MP or MPG.
   e. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   2. Hubbell Premise Wiring.
   3. KRONE Incorporated.
   4. Leviton Voice & Data Division.
   5. Molex Premise Networks; a division of Molex, Inc.
   6. Panduit Corp.
   7. Siemon Co. (The).
   8. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
   9. Or, Equal

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
   1. Number of Terminals per Field: One for each conductor in assigned cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of provided cables.
   1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, 4-pair cables in 72-inch lengths; terminated with 8-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
   2. Patch cords shall have color-coded boots for circuit identification.
2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Berk-Tek; a Nexans company.
   2. CommScope, Inc.
   3. Corning Cable Systems.
   4. General Cable Technologies Corporation.
   5. Mohawk; a division of Belden CDT.
   6. Optical Connectivity Solutions Division; Emerson Network Power.
   7. Superior Essex Inc.
   8. SYSTIMAX Solutions.
   9. 3M.
   10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
   11. Or, Equal

B. Description: Multimode, 50/125-micrometer, 24-fiber, nonconductive, tight buffer, optical fiber cable.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA/EIA-568-B.3 for performance specifications.
   3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
      a. General Purpose, Nonconductive: Type OFN or OFNG.
      b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
      c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
   4. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
   5. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ADC.
   3. Berk-Tek; a Nexans company.
   4. Corning Cable Systems.
   5. Hubbell Premise Wiring.
6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Or, Equal.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:
   2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
   3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 GROUNDING
A. Comply with requirements in Section 260526 Grounding and Bonding for grounding conductors and connectors.
B. Comply with ANSI-J-STD-607-A.

2.8 IDENTIFICATION PRODUCTS
A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.9 SOURCE QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to evaluate cables.
B. Factory test cables on reels according to TIA/EIA-568-B.1.
C. Factory test UTP cables according to TIA/EIA-568-B.2.
D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
E. Cable will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES
A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS
A. Wiring Method: Provide cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   1. Provide plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Section 26 05 33 Raceway and Boxes.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 PROVISION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 Communications Equipment Room Fittings. Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Section 260533 Raceway and Boxes for provision of conduits and wireways.

E. Provide manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Placement in Communications Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is located, or in the corner of room where multiple sheets of plywood are located around perimeter walls of room.
   2. Provide cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard when entering room from overhead.
   4. Extend conduits 12 inches above finished floor.
   5. Provide metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Provide backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 PROVISION OF CABLES

A. General Requirements for Cabling:
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Provide 110-style IDC termination hardware unless otherwise indicated.
   4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

6. Provide lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

8. Do not provide bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during placement and replace it with new cable.

9. Cold-Weather Placement: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

10. In the communications equipment room, provide a 10-foot long service loop on each end of cable.

11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

B. UTP Cable Placement:
   2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

C. Optical Fiber Cable Placement:
   2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

D. Open-Cable Placement:
   1. Provide cabling with horizontal and vertical cable guides in tel/data communications spaces with terminating hardware and interconnection equipment.
   2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078400 Firestopping. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Provide grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond all metallic equipment to the grounding bus bar with No. 6 AWG equipment grounding conductor or larger unless noted otherwise in the drawings.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 Identification.
   1. Administration Class: 1.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 099100 Painting for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
C. See Section 2711 00 Communications Equipment Rooms for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Section 271100 Communications Equipment Rooms for cable and asset management software.

E. Cable Schedule: Provide a cable schedule in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Provide an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for tel/data communications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
   3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      a. Individually number conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
      b. Label each unit and field within distribution racks and frames.
   4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color complying TIA/EIA 606-A, for the following:
   1. Cables using flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:
      1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
      2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 27 13 00
SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pathways.
   2. UTP cabling.
   3. 50/125-micrometer, optical fiber cabling.
   5. Cable connecting hardware, patch panels, and cross-connects.
   6. Tel/data communications outlet/connectors.
   7. Cabling system identification products.
   8. Cable management system.

B. RELATED SECTIONS:
   1. Section 078400 Firestopping
   2. Section 260526 Grounding and Bonding
   3. Section 260533 Raceway and Boxes
   4. Section 260553 Identification
   5. Section 262726 Wiring Devices
   6. Section 271100 Communications Equipment Rooms
   7. Section 271300 Communications Backbone Cabling

1.2 APPLICABLE STANDARDS:

A. ANSI/EIA/TIA - 568-A, Commercial Building Telecommunication Cabling.
C. TSB-72, Centralized Cabling Guidelines, October 1995.
D. TSB-75, Additional Horizontal Cabling Practices for Open Offices, August 1996.
E. TSB-95, Additional Field Testing Requirements for Category 5, October 1999.
F. ANSI/EIA/TIA - 568-A, Addendum 1, Propagation Delay and Delay Skew Specifications for 100 ohm 4-Pair Cable, September 1997.
H. ANSI/EIA/TIA - 568-A, Addendum 3, Hybrid and Bundled Cables.

J. ANSI/EIA/TIA - 568-B.2-1, Transmission Performance Specification for 4-pair 100 Ohm Category 6 Cabling.


L. EIA/TIA-455-61, FOTP-61, Measurement of Fiber or Cable Attenuation using an OTDR.

M. IEEE 802.3, Carrier Sense Multiple Access with Collision Detection.


R. ANSI/EIA/TIA - 729, Screened, 100 Ohm Twisted Pair Cabling.


V. California Electrical Code (CEC).

W. Provide and test all cabling in accordance with the most recent edition BICSI publications:

X. BICSI - “Telecommunications Distribution Methods Manual.”

Y. BICSI - “Cabling Installation Manual.”

1.3 GENERAL REQUIREMENTS

A. In order to qualify for provision of the tel/data communications system, the Contractor must possess the required license classification, trade certifications, a performance history, experience in the placement and termination of fiber optics cable systems, and proof of time in business.

B. License Classification: Contractor must possess a valid C-7 California State Contractor's License. This license must have been issued two years prior to the date of this bid. No other license classification in acceptable.

C. BICSI Certifications: Contractor will use personnel certified by the trade organization BICSI. The vendor must have a Registered Communications Distribution Designer (RCDD®) on staff who will be ultimately responsible for this project. The RCDD must have sufficient experience in this type project as to be able to lend adequate technical support to the field forces during
placement, during the warranty period, and during any extended warranty periods or maintenance contracts. The vendor must attach a resume of the responsible RCDD to the vendor's submittal for evaluation. Should the RCDD assigned to this project change during the project, the new RCDD assigned must also submit a resume for review by the District's Representative. The vendor must also have BICSI registered technicians on staff and assign them to this project. The project shall be staffed at all times by technicians, who, in the role of lead craftsperson, will be able to provide leadership and technical resources for the remaining crafts persons on the project. A minimum of 30 percent of personnel shall be BICSI registered communications technicians.

D. Performance History: Contractor must have successfully performed at least three projects of similar scope, within two years of the date of this bid. Proof of performance shall be in the form of reference sheets which shall include a brief description of the project, the beginning and ending contract price, the project foreman or superintendent's name, and the name, address, and telephone number of a project contact.

E. Fiber Optics Experience: Contractor must be able to prove to the satisfaction of District's Representative that they have had significant experience in the placement of fiber optics cable systems. Work must include placement of fiber optics cable in innerduct, fiber breakout systems, fiber termination, a knowledge of interconnect equipment, and a thorough knowledge of testing procedures. Contractor must provide a minimum of three (3) references supports its claim of experience for similar projects within the two years prior to this bid. Documentation must be included with the submittal documents.

F. Time in Business: Contractor must have been in business, and in the business of providing tel/data communications systems, continuously, for a period of at least three years, prior to the date of this bid. Contractor must submit at least one project reference for each of the three years prior to the date of this bid. The contractor must also maintain a full time staff at an established business location having appropriate parts and service facilities and the ability to provide a one-hour response time to this campus. Contractor's unable to meet these requirements will not be considered to be an acceptable Contractor for this project.

1.4 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.


C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. IDC: Insulation displacement connector.

H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

I. LAN: Local area network.
J. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

K. RCDD: Registered Communications Distribution Designer.

L. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.

M. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.

N. UTP: Unshielded twisted pair.

O. Main Distribution Facility (MDF): The MDF is the location, within a building or complex of buildings, where the entire tel/data communications system originates. It may include the physical location, enclosure, wire and cable management hardware, termination hardware, distribution hardware, and equipment racks.

P. Intermediate Distribution Facility (IDF): The IDF is the location in a building where a transition between the backbone or vertical riser system and the horizontal distribution system occurs. It may include the physical location, enclosure, wire and cable management hardware, termination hardware, distribution hardware, and equipment racks. In this case, the IDF's are collocated with the CTBs (Computer Terminal Backboards) and provide the interface location between fiber distribution cable (backbone) and station cable (horizontal distribution).

Q. Backbone Pathway: The backbone pathway consists of a series of conduits or chases, which connect the MDF to IDF's or IDF's to IDF's. It generally houses the vertical or backbone system.

R. Backboard: Backboard generally refers to the plywood sheeting lining the walls of tel/data communications facilities. Backboard may also refer to the entire wall-mounted assembly, including wire management, wiring blocks, and equipment racks. In this case, the term Backboard is fully interchangeable with CTB and the equipment required to fulfill the scope of work below.

1.5 SYSTEM DESCRIPTION

A. The tel/data communications structured cabling system shall consist of four components: termination equipment, a fiber optics backbone, a copper twisted-pair backbone (voice) and twisted-pair copper workstation cabling (voice and data). The central location shall house an MDF and each of the other locations shall house an IDF. Each fiber optics cable shall originate in the MDF and shall be terminated in its respective IDF. All fiber optics cables shall be enclosed in innerduct. The combination of innerduct with fiber optic cable shall be routed through a system of conduits and raceway provided by the responsible contractor for that discipline, in accordance with the drawings. The drawings depict a typical conduit layout and fiber cable routing. All copper backbone cables shall be routed along with the fiber cable, shall originate at the MDF, and terminate in each of the IDF's. From each IDF, one (1) or more twisted-pair copper cables shall be routed to each data outlet location, via routing established by the Contractor, within its respective building or buildings. These cables shall originate in an IDF and terminate in its respective data outlet location.

1.6 SCOPE OF WORK

A. Contractor shall provide materials for a complete wiring/cabling and conduit system in accordance with this specification and the drawings. Contractor shall be responsible for
providing a complete wiring/cabling and conduit system including all necessary components, whether included in this specification or not.

B. The work shall include cable (fiber optic and twisted-pair copper), innerduct, fiber interconnect equipment, connectors (fiber and copper), jumpers (twisted-pair copper), wiring blocks, and data communications outlets. The necessary material and equipment are depicted throughout the specifications and applicable drawings. Contractor is responsible to supply District’s Representative with all necessary components, whether included in the specifications and drawings or not.

C. At each IDF location, Contractor to provide two (2) 20 amp dedicated isolated ground circuits to a location within 6’ of the equipment rack. All receptacles in these locations are to be wired to separate circuit breakers, regardless of available power unless instructed otherwise by District’s Representative.

D. The work performed under this specification shall be of good quality and performed in a workmanlike manner. In this context, “good quality” means the work shall meet industry technical standards and quality of appearance. The District’s Representative reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

1.7 MANUFACTURER

A. Throughout this specification, Leviton and other manufacturers are cited, along with specific part numbers. These citations are for the purpose of establishing minimum quality and performance criteria.

B. Unless specified otherwise in the following, the equipment provided shall fall into five classes, and with exception of Class 5, all of the material within a single class shall be the standard product of one manufacturer. The five classes are as follows:

C. Class One: Fiber optics cable, copper cable (both station and backbone), copper jumpers, blocking kits, interconnection devices, wiring blocks, connectors (fiber and copper), and tel/data communications outlets. All material covered in Class One meet the following warranty:

D. Balanced Twisted-pair: A minimum twenty five year, category 6 cabling system warranty shall be provided for an end-to-end balanced twisted-pair channel model placement which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement of any defective components in the channel. The balanced twisted-pair cabling system warranty must include a worst-case channel performance guarantee.

E. Optical Fiber: A twenty year, optical fiber cabling system warranty shall be provided for an end-to-end optical fiber channel model placement which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement of any defective components in the channel. The optical fiber cabling system warranty must include a worst-case channel performance guarantee.

F. PANDUIT® CERTIFICATION PLUS™ System Warranty: A CERTIFICATION PLUS™ System Warranty shall provide a complete system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of at least twenty five years.

G. PANDUIT® PCI Contractor Agreement: Contractor shall be a factory registered PANDUIT® PCI for the network work. The Contractor shall have completed standards based product and
placement training. A copy of the PCI Contractor Registration shall be submitted in the proposal.

H. Class Two: Fiber innerduct. All material covered in Class Two shall be equal in quality and performance to that manufactured by Carlon or Armaco, no substitutions.

I. Class Three: Equipment racks and cabinets. All material covered in Class Three shall be equal in quality and performance to that manufactured by Saunders or CPI Dracon, no substitutions.

J. Class Four: Wire management panels. All material covered in Class Four shall meet the warranty requirements listed for Class One.

K. Class Five: Wire ties, printed labels, "D" rings, nuts, bolts, screws, and other miscellaneous hardware

1.8 HORIZONTAL CABLEING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the tel/data communications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

B. TIA/EIA-568-B.1 requires that a minimum of two tel/data communications outlet/connector be provided for each work area.

C. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the tel/data communications outlet/connector.

D. Bridged taps and splices shall not be provided in the horizontal cabling.

E. Splitters shall not be provided as part of the optical fiber cabling.

F. A work area is approximately 100 sq. ft., and includes the components that extend from the tel/data communications outlet/connector to the station equipment.

G. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

1.9 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.10 SUBMITTALS

A. Submit in accordance with of Section 013323 Shop Drawings, Product Data and Samples.

B. Product Data: For each type of product indicated.

C. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the District’s Representative.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

3. Cabling administration drawings and printouts.

4. Wiring diagrams to show typical wiring schematics, including the following:
   b. Patch panels.
   c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the provided components.

6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

D. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration.

E. Qualification Data: For Contractor, qualified layout technician, supervisor, and field inspector.

F. Source quality-control reports.

G. Field quality-control reports.

H. Maintenance Data: For splices and connectors to include in maintenance manuals.

I. Additional Submittal requirements:

1. Include a copy of the Contractor's valid C-7 California State Contractor's License, BICSI certifications, the information required in Section 1.4 above, and a list of instrumentation to be used for system testing. Include comparative specification listing of any substitutions and a complete listing of the characteristics of the equipment in the specifications. Also enclose samples of proposed cable markers and labeling. Include a complete, detailed satellite closet count, proposed floor plan and backboard plan, workstation count, and bill-of-materials. Failing to include all of the required information shall be deemed non-responsive and may be disqualified, at the discretion of the District.

2. Any proposed equal item offered shall be substantiated fully to prove equality. We reserve the right to require a complete sample of any proposed equal item and may, if necessary, request a sample tested by and a copy of the test results by an independent testing laboratory to prove equality. The decision of the District's Representative regarding equality of proposed equal items is considered final.

1.11 QUALITY ASSURANCE

A. Contractor Qualifications: Contractor must have personnel certified by BICSI for cabling on staff.
1. **Layout Responsibility:** Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. **Supervision:** This scope shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

3. **Testing Supervisor:** Currently certified by BICSI as an RCDD to supervise on-site testing.

B. **Testing Agency Qualifications:** An NRTL.

   1. Testing Agency’s Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. **Surface-Burning Characteristics:** As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

D. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. **Tel/data communications Pathways and Spaces:** Comply with TIA/EIA-569-A.

F. **Grounding:** Comply with ANSI-J-STD-607-A.

1.12 **GUARANTEE**

A. One firm to assume full responsibility for performance on all work of this section. Guarantee all equipment against defects in material and workmanship for one (1) year, and provide on-the-premises service during normal working hours for one year, at no cost to purchaser if trouble is not caused by misuse, abuse, or accident, or at current labor rates if so caused. Provide manufacturer’s written one-year guarantee for equipment and parts to District’s Representative. Class one products require a warranty program of twenty-five years.

B. Service shall normally be available within 24 hours from service department of authorized distributor of manufacturer by factory trained servicemen.

C. On-the-premises service at other than normal working hours to also be available, but labor charges for such calls to be paid by purchaser at current labor rates.

1.13 **DELIVERY, STORAGE, AND HANDLING**

A. Test cables upon receipt at Project site.

   1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight.

   2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.

   3. Test each pair of UTP cable for open and short circuits.
1.14 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or provide cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.15 COORDINATION

A. Coordinate layout and placement of tel/data communications pathways and cabling with District's Representative for tel/data communications and LAN equipment and service suppliers.

B. Coordinate tel/data communications outlet/connector locations with location of power receptacles at each work area.

1.16 FUNCTION AND OPERATION

A. The intended function of the data communications cable system is to transmit data signals from a central location to several individual data outlet locations. Upon completion of the work outline in this specification, the system shall be capable of transmitting data signals at 1000 Base-T or Category 6 levels.

B. The multi-mode fiber optics cable system shall be capable of transmitting signals with a bandwidth of up to 500 MHz at either 850 or 1300 nm. The cumulative signal loss, through connectors, jumpers, couplers, and fiber cable, shall be less than 10 dB. The single-mode fiber optics cable system shall be capable of transmitting signals with a bandwidth of up to 500 MHz at both 1310 and 1550 nm. The cumulative signal loss, through connectors, jumpers, couplers, and fiber cable shall be less than 10 dB.

C. Work station cable, commencing at the wiring blocks, shall be provided in accordance with ANSI/EIA/TIA TSB standards, shall meet or exceed PANDUIT® CERTIFICATION PLUS™ System Warranty, and shall be capable of transmitting a signal at Category 6 level with acceptable attenuation losses and cross-talk attenuation. The entire workstation cable system, including wiring blocks, cable, and tel/data communications outlets shall be tested for Category 6 compliance, so an extended warranty can be provided to EGUSD.

D. Voice cables shall be Category 6 compliant, or better.

1.17 EXTRA MATERIALS

A. Provide extra materials that match products placed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Patch-Panel Units: One of each type.

C. Connecting Blocks: One of each type.

D. Device Plates: One of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.
B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

C. Cable Trays manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cable Management Solutions, Inc.
   2. Cablofil Inc.
   3. Cooper B-Line, Inc.
   4. Or, Equal

D. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick.
   2. Trough Cable Trays: Nominally 6 inches wide.
   3. Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.
   4. Channel Cable Trays: One-piece construction, nominally 4 inches wide. Slot spacing shall not exceed 4-1/2 inches on center.

E. Conduit and Boxes: Comply with requirements in Section 260533 Raceway and Boxes for Electrical Systems. Flexible metal conduit shall not be used.
   1. Outlet boxes shall be no smaller than 4-11/16 inches square and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Panduit.
   2. Berk-Tek; a Nexans company.
   3. CommScope, Inc.
   4. Mohawk; a division of Belden CDT.
   5. Tyco Electronics/AMP Netconnect; Tyco International Ltd
   6. Or, Equal.

B. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
4. 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. Communications, Limited Purpose: Type CMX.
   e. Multipurpose: Type MP or MPG.
   f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
   g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Premise Wiring.
   2. Leviton Voice & Data Division.
   3. Panduit Corp.
   4. Tyco Electronics/AMP Netconnect: Tyco International Ltd.
   5. Or, Equal

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
   1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of provided cables.
   1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in 72-inch lengths; terminated with eight-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
   2. Patch cords shall have color-coded boots for circuit identification.
2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Berk-Tek; a Nexans company.
   2. CommScope, Inc.
   3. Mohawk; a division of Belden CDT.
   4. 3M.
   5. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
   6. Or, Equal

B. Description: Multimode, 50/125-micrometer, 6-fiber, nonconductive, tight buffer, optical fiber cable.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA/EIA-568-B.3 for performance specifications.
   3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. General Purpose, Nonconductive: Type OFN or OFNG.
      b. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
      c. General Purpose, Conductive: Type OFC or OFCG.
      d. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
      e. Riser Rated, Conductive: Type OFCR, complying with UL 1666.
   5. Conductive cable shall be steel armored type.
   6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
   7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:
   2. Cable cordage jacket, fiber, unit, and group color according to TIA/EIA-598-B.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Berk-Tek; a Nexans company.
   3. Corning Cable Systems.
   4. Or, Equal

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:
   2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
   3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 CONSOLIDATION POINTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chatsworth Products, Inc.
   2. Panduit Corp.
   3. Hubbell Premise Wiring.
   4. Ortronics, Inc.
   5. Or, Equal

B. Description: Consolidation points shall comply with requirements for cable connecting hardware.
   1. Number of Terminals per Field: One for each conductor in assigned cables.
   2. Number of Connectors per Field:
      a. One for each four-pair UTP cable indicated.
      b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.

C. Mounting: Wall.

D. NRTL listed as complying with UL 50 and UL 1863.

E. When provided in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.8 TEL/DATA COMMUNICATIONS OUTLET/CONNECTORS


B. Workstation Outlets: Three-port-connector assemblies mounted in multigang faceplate.
   2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 Wiring Devices.
   3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
a. Flush mounting jacks, positioning the cord at a 45-degree angle.

4. Legend: Factory labeled by silk-screening or engraving for stainless steel faceplates.

2.9 GROUNDING

A. Comply with requirements in Section 260526 Grounding and Bonding for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 Identification.

2.11 CABLE MANAGEMENT SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. iTRACS Corporation.
   2. Telsoft Solutions.
   3. Or, Equal

B. Description: Computer-based cable management system, with integrated database and graphic capabilities.

C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

D. Information shall be presented in database view, schematic plans, or technical drawings.
   1. AutoCAD drawing software shall be used as drawing and schematic plans software.

E. System shall interface with the following testing and recording devices:
   1. Direct upload tests from circuit testing instrument into the personal computer.
   2. Direct download circuit labeling into labeling printer.

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Place cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   1. Use plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Section 260533 Raceway and Boxes.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 USE OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 Communications Equipment Rooms. Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Section 260533 Raceway and Boxes for provision of conduits and wireways.

E. Use manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Placement in Communications Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is located, or in the corner of room where multiple sheets of plywood are placed around perimeter walls of room.
   2. Use cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard when entering room from overhead.
   4. Extend conduits 12 inches above finished floor.
   5. Use metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Place backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.
3.4 PLACEMENT OF CABLES

A. Comply with NECA 1

B. General Requirements for Cabling:
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Provide 110-style IDC termination hardware unless otherwise indicated.
   4. Consolidation points may be used only for making a direct connection to tel/data communications outlet/connectors:
      a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
      b. Locate consolidation points for UTP at least 49 feet from communications equipment room.
   5. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   7. Provide lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Provide lacing bars and distribution spools.
   9. Do not place bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during placement and replace it with new cable.
   10. Cold-Weather Placement: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   11. In the communications equipment room, leave a 10-foot-long service loop on each end of cable.
   12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Placement:
   2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Placement:
   2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Placement:
   1. Place cabling with horizontal and vertical cable guides in tel/data communications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
   6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING
   A. Comply with requirements in Section 078400 Firestopping.
   B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
   C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING
   A. Provide grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
   B. Comply with ANSI-J-STD-607-A.
C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to building electrical grounding system.

D. Bond metallic equipment to the grounding bus bar, using no smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 Identification.
   1. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Provide an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for tel/data communications closets, backbone pathways and cables terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Provide electronic record of all drawings, in software and format selected by the District’s Representative.

F. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Trcughs: Label each cable at intervals not exceeding 15 feet.
   4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
      b. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.
Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

6. Uniquely identify/label work area cables extending from the MUTOA to the work area. Cables may not exceed the length stated on the MUTOA label.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests, inspections and provide reports.

C. Tests and Inspections:


2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Provide and test all cabling in accordance with the most recent edition BICSI publications.

5. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

6. UTP Performance Tests:

a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.

8. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are provided.
   a. Voice Tests: These tests assume that dial tone service has been provided. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
   b. Data Tests: These tests assume the Information Technology Staff has a network in place and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

9. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

10. End-to-end cabling will be considered defective if it does not pass tests and inspections.

11. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train District IT personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Coordinate with the District’s Representative for training schedule.

END OF SECTION 27 15 00
SECTION 27 51 16

PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Power amplifiers.
   2. Loudspeakers.
   3. Conductors and cables.
   4. Raceways.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
      a. Identify terminals to facilitate installation, operation, and maintenance.
      b. Single-line diagram showing interconnection of components.
      c. Cabling diagram showing cable routing.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
D. Qualification Data: For qualified Installer.

E. Field quality-control reports.

F. Operation and Maintenance Data: For public address and mass notification systems to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain public address and mass notification systems from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alpha Communications.
2. Altec Lansing Technologies, Inc.
3. Atlas Sound LP.
4. Bogen Communications, Inc.
7. Electro-Voice; Telex Communications, Inc.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:
   1. Selectively connect any zone to any available signal channel.
   2. Selectively control sound from microphone outlets and other inputs.
3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.

4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.

5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.

6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.

2.3 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.4 POWER AMPLIFIERS

A. Mounting: Wall.

B. Output Power: 70-V balanced line, 100 watts.

C. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.


E. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.

F. Output Regulation: Less than 2 dB from full to no load.

G. Controls: On-off, input levels, and low-cut filter.

H. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.5 LOUDSPEAKERS

A. Cone-Type Loudspeakers:
   1. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
   2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
   3. Size: 8 inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.
   5. Rated Output Level: 10 W.
6. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.

7. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and shop primed for field painting.


B. Horn-Type Loudspeakers:
   1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
   2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
   3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
   4. Dispersion Angle: 130 by 110 degrees.
   6. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.

2.6 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multipair, untinned solid copper.
   1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
   2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
   3. Plenum Cable: Listed and labeled for plenum installation.

2.7 RACEWAYS

A. Conduit and Boxes: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
   1. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

PART 3 EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer’s limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 Section “Raceway and Boxes for Electrical Systems” for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.

3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer’s limitations on bending radii. Install lacing bars and distribution spools.

5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.

3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
3.4 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Equipment Cabinets and Racks:
   1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
   2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
   3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

D. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

E. Wall-Mounted Outlets: Flush mounted.

F. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

G. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

H. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

I. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Schedule tests with at least seven days' advance notice of test performance.
   2. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
   a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
   b. Repeat test for each separately controlled zone of loudspeakers.
   c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.

6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

D. Public address and mass notification systems will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.
   1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.
3.8 DEMONSTRATION

A. Train District's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

END OF SECTION 27 51 16
PART 1  GENERAL

1.1  SUMMARY

A. Section Includes: Labor, materials, equipment, and services for a complete gymnasium sound reinforcement system and testing of the assembled sound reinforcement system.

B. Provide and install:
   1. Assembly and setup of the system for normal operation, testing, and training of operators and users.
   2. Permanently installed sound reinforcement systems and equipment cabinets including:
      a. Processing equipment
      b. Amplifiers
      c. Cordless and wired microphone systems
      d. Speakers
      e. Cabling

C. RELATED SECTIONS:
   1. 26 05 00 – Common Work Results for Electrical
   2. 26 05 26 – Grounding and Bonding
   3. 26 05 29 – Hangers and Supports
   4. 26 05 33 – Raceway and Boxes
   5. 27 05 00 – Common Work Results for Communications
   6. 27 15 00 – Communications Horizontal Cabling

D. APPLICABLE STANDARDS AND CODES:
   1. In addition to all applicable local and state codes, provide the work under provisions of the latest revisions of all applicable standards and specifications of the following:
      a. CBC - California Building Code
      b. NAB - National Association of Broadcasters
      c. NRTL - National Recognized Testing Laboratory approved by OSHA
      d. EIA - Electrical Industries Association
      e. CEC - California Electrical Code

1.2  DEFINITION

A. Installer: Sound reinforcement system subcontractor.

1.3  SYSTEM DESCRIPTION
A. Material and equipment specified have been selected based on acceptable quality and performance and coordinated to function as components of the included systems. Similar equipment (speakers, amplifiers, etc.) described and furnished under these specifications shall be the standard product of the manufacturer.

B. Provide the work complete and the system fully operational as shown on the Plans and described herein.

C. Electrical conduit, wiring and receptacle boxes for electrical power to sound equipment and conduit and standard electrical boxes, including terminal cabinets, for the sound system and other communications systems shall be installed in accordance to Section 26.

D. Comply with applicable provisions of Section 01 45 23, "Testing and Inspecting Services".

1.4 SUBMITTALS

A. Submit 6 copies of the following as part of the submittals:

1. A list describing at least 5 installations comparable in scope and nature as specified. Include the name, current position, address, and telephone number of a representative of each installation owner.

2. Proof that the firm has been regularly engaged in the business of designing, installing, and servicing systems and equipment as specified, for at least the past 5 consecutive years.

3. Provide a listing of test equipment including a list showing procedures and service contacts.

4. A complete list of quantities, including materials, components, devices, and equipment required for the Work. Tabulate the list of quantities for the components of each system as specified, and provide the following information for each item listed:

   a. Quantity.
   b. Description.
   c. Manufacturer's name and model number.
   d. Corresponding specification section and article number.

5. Complete, comprehensive, single-line diagrams in computer aided drafting (CAD) format including equipment, devices, connectors, wiring, and wire numbering completely identified. Include label designations and locations.

6. Complete, scaled (1" = 1'-0" minimum) in CAD format, equipment rack elevation drawings, including equipment designation, manufacturer's name, model number, rack location, and rack designation.

7. Complete catalog cut sheets and manufacturer's literature.

B. Closeout Documents:

1. Prior to substantial completion the contractor shall submit the following:

   a. Test reports as specified herein.
   b. Written warranties certifications.
c. Copy of FCC License for the Hearing Assistance System FM transmitters if required.
d. Copy of certificate of cables complying with fire retardant requirements.
e. Closeout Submittals: Submit 5 sets of as-built drawings.

1.5 QUALITY ASSURANCE

A. Manufacturers' Qualifications:
   1. Firms regularly engaged in the manufacture of sound reinforcement equipment.
   2. Manufacturer’s products shall have been satisfactorily used in similar service for a minimum of 3 years.
   3. The manufacturers shall franchise installers for the supply, design, installation, and maintenance of the products.
   4. Designs and markets professional sound equipment for use in amplifying, reproduction and recording.

B. Installer Qualifications:
   1. The work of this section will be contracted to a single firm, referred to as the installer, for undivided responsibility.
   2. A firm with a minimum of 5 years successful installation experience similar in scope with this project.
   3. Maintain a fully staffed and equipped maintenance and repair facility.
   4. Installer shall be primarily engaged in the supply, design, installation, and maintenance of commercial duty sound systems and franchised by the manufacturers of the major equipment items for the supply of these systems and not be an electrical subcontractor.
   5. Installer shall be licensed as required by the county or state to do the work contemplated.
   6. Installer shall hold factory computer control system certification.
   7. Installer support services shall include:
      a. Service and maintenance manuals.
      b. Schematic information and parts list.
      c. Maintenance of a factory stock of replacement parts.
      d. Factory repair service.
   8. The sound equipment installer shall have the capabilities and in-house facilities for installation, shop fabrication, and repair service of professional sound systems.

C. Code Compliance: Comply with national, state, and local electrical and structural codes as applicable to installation and construction of the sound reinforcement system.

D. Provide equipment listed and labeled by an OSHA approved Nationally Recognized Testing Laboratory (NRTL).

E. All wiring shall be in raceways and conduits.

F. All equipment AC power shall have lightning surge protection.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle equipment components carefully to prevent breakage, denting, and scoring the finish.

B. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

C. Store equipment in a clean, dry space, in original cartons and protect from dirt, physical damage, weather, and construction traffic. Protect electronic components from dust debris and water.

1.7 SEQUENCING

A. Furnish a listing of test equipment presently owned and to be used for this project. Include make, model number, serial number, and the date of last equipment calibration. Test equipment shall be calibrated within the past 24 months of contract award.

1.8 WARRANTY

A. Components, parts, loudspeakers and associated acoustic products, and assemblies furnished and installed shall be warranted in writing for:
   1. 1 year after date of Substantial Completion against defects in labor.
   2. 3 years after date of Substantial Completion against defects in materials.

B. Installer shall maintain regular service facilities and provide a qualified technician familiar with the work at the site within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.
   1. Provide material, devices, equipment, and personnel necessary for repairs.
   2. Provide accepted temporary, alternate equipment, if required by the District, complete and operational within 48 hours after notification of malfunction, at no additional cost during the first year of warranty.

C. Installer shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, Installer shall provide substitute systems, equipment, and devices acceptable to the District for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

D. Installer shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the District.

1.9 MAINTENANCE

A. Manual: Prepare and submit, before acceptance testing, copies of an operational and maintenance manual, neatly bound. Provide 4 copies for the District's use. Manual shall include:
   1. Basic power on/off and operational procedures.
   2. Manufacturer's service literature for each major system component.
   3. A system block diagram with input/output terminations identified including wiring diagrams.
4. A copy of the verification test report.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials, equipment, and apparatus shall be new and of the latest design or model offered for sale by the manufacturer.

B. Items of equipment and apparatus are identified part number and manufacturer are to establish quality of equipment desired for this system.

1. For items identified by part number and manufacturer, performance specifications published in the most recent manufacturer's data sheets available at the time of bidding this contract shall apply to the work as specified.

2. For those items that are not identified by part number and manufacturer, select items that conform to the functional and technical specifications and submit for A/E approval all technical data that is available from the supplier or manufacturer.

2.2 SYSTEM DESCRIPTION AND FUNCTION

A. The systems shall provide inputs from microphones and a CD/DVD player with MP3 input.

B. A dynamic range limiter/noise gate shall protect the systems from overload distortion and subsequent speaker damage and to eliminate undesirable background noise between announcements during sporting events.

2.3 COMPONENTS

A. The sound systems shall include, but not be limited to the following (See also construction documents single line block diagrams and riser diagrams):

1. Gymnasium Sound System Equipment List:
   a. One (1) floor mounted equipment cabinet with:
   b. Two (2) 600W two-channel power amplifiers.
   c. One (1) 8 input mixer/preamplifier.
   d. One (1) digital sound processor.
   e. One (1) rack mounted CD/DVD player with MP3 support.
   f. Two (2) wireless microphone systems.
   g. One (1) rack mounted assistive listening system with the following items:
   1). Listen Technologies LT-800-072 Base Transmitter (Qty: 1 ea.)
   2). Listen Technologies LA-326 Rack mount kit (Qty: 1 ea.)
   3). Listen Technologies LA-122 Universal antenna. (Qty: 1 ea.) Mount as indicated on plans. If antenna is mounted remote from base transmitter use RG58 for less than 100ft or RG8 for more than 100ft runs (50 ohm).
   4). Listen Technologies LR-5200-072 Advanced Intelligent DSP RF Receiver (72 MHz) receiver (Qty: 65 ea.)
   5). Listen Technologies LA-401 Universal Ear Speaker (Qty: 65 ea.)
6). Listen Technologies LA-430 Intelligent Earphone/Neck Loop Lanyard. (Qty: 65 ea.)
7). Listen Technologies LPT-A107-B Dual RCA to Dual RCA Cable 6.6 ft. (Qty: 1 ea.)
8). Listen Technologies LA-381-01 Intelligent 12-Unit Charging Tray (Qty: 6 ea.)
9). Listen Technologies LA-304 ADA Access/Compliance signage kit. (Qty: 1 ea.)

h. Power sequencing system.
i. Blank panels as required.
j. Two (2) microphones with on-off switch and 50-foot microphone cables with XLR connectors and 24 gauge conductors.
k. Two (2) microphone desk stands.
l. Four (4) suspended box loudspeakers for Gymnasium.
m. Two (2) ceiling mounted loudspeakers for Lobby.
n. Four (4) microphone receptacles.
o. Microphone cable, as required.
p. Speaker cable, as required.

2. Gymnasium Building Classroom Sound System Equipment List:
a. One (1) wall mounted equipment cabinet with:
b. One (1) 100W mixer/power amplifier.
c. One (1) wireless microphone system.
d. One (1) rack mounted assistive listening system with receivers.
e. Blank panels as required
f. Four (4) ceiling mounted speakers.
g. Speaker cable, as required.

3. Team Room/Classroom Sound System Equipment List:
a. One (1) wall mounted equipment cabinet with:
b. One (1) 60W mixer/power amplifier.
c. One (1) wireless microphone system.
d. One (1) rack mounted assistive listening system with receivers.
e. Blank panels as required
f. Four (4) ceiling mounted speakers.
g. Speaker cable, as required.

4. Training/Classroom Sound System Equipment List:
a. One (1) wall mounted equipment cabinet with:
b. One (1) 60W mixer/power amplifier.
c. One (1) wireless microphone system.
d. One (1) rack mounted assistive listening system with receivers.
e. Blank panels as required
f. Three (3) ceiling mounted speakers.
g. Speaker cable, as required.

5. Fitness Center Sound System Equipment List:
   a. One (1) wall mounted equipment cabinet with:
   b. One (1) 250W mixer/power amplifier.
   c. One (1) digital equalizer.
   d. One (1) rack mounted CD/DVD player with MP3 support.
   e. Blank panels as required
   f. Twelve (12) ceiling mounted speakers.
   g. Speaker cable, as required.

6. Spin Room Sound System Equipment List:
   a. One (1) wall mounted equipment cabinet with:
   b. One (1) 100W mixer/power amplifier.
   c. One (1) digital equalizer.
   d. One (1) rack mounted CD/DVD player with MP3 support.
   e. One (1) wireless microphone system.
   f. One (1) rack mounted assistive listening system with receivers.
   g. Blank panels as required
   h. Four (4) ceiling mounted speakers.
   i. Speaker cable, as required.

7. Mat Lab Sound System Equipment List:
   a. One (1) wall mounted equipment cabinet with:
   b. One (1) 100W mixer/power amplifier.
   c. One (1) digital equalizer.
   d. One (1) rack mounted CD/DVD player with MP3 support.
   e. One (1) wireless microphone system.
   f. One (1) rack mounted assistive listening system with receivers.
   g. Blank panels as required
   h. Four (4) ceiling mounted speakers.
   i. Speaker cable, as required.

8. Portable Assistive Listening System:
   1). Furnish portable assistive listening systems Listen Technologies LKS-4
      ListenTALK Portable ADA Kit (Qty: 4 - One for each building; Gym Annex
      (GA), Gymnasium (G), Locker Building (L), Team Building (T).
   2). Portable systems to include:
      a). Listen Technologies LK-1 ListenTALK Transceivers (Qty: 4 ea.)
      b). Listen Technologies LA-451 Headset 1 (Ear Speaker w/Boom Mic) (Qty:
         1 ea.)
c). Listen Technologies LA-401 Universal Ear Speaker (Qty: 3 ea.)
e). Listen Technologies LA-166 Neck Loop (Qty: 2 ea.)
f). Listen Technologies LA-423-01 4-Port USB Charger (Qty: 1 ea.)
g). Listen Technologies LA-436 Microphone Input / Headphone Output Cable (Qty: 1 ea.)
h). Listen Technologies LA-483 Soft Shell Case 4 (Qty: 1 ea.)

2.4 EQUIPMENT PERFORMANCE SPECIFICATIONS
A. The performance specifications for components shall be as published in the most recent manufacturer's data sheets available at the time of bidding this contract and shall be applicable to the present work.

2.5 WIRING AND CONDUCTORS
A. Provide microphone and line level cable, West Penn #291, in conduit.
B. Provide loud speaker cable, West Penn #227, in conduit.

2.6 ACCESSORIES
A. Materials shall be new and of the manufacturer's latest design, and permanently labeled with the manufacturer's name, model number, and serial number. Active circuitry shall be solid state and rated for continuous duty use. Similar devices shall be of the same manufacturer.
B. Electronic equipment shall be of the dead-front type and designed for 19 inch rack mounting unless otherwise noted. Access to terminals and components shall not require side access. Equipment shall be rated for continuous use and continuous duty.
C. Do not provide engraving, labels, decals, or other identification on any device, equipment, or miscellaneous component without prior approval from the A/E.
D. Provide intelligible, permanent, professionally engraved identification on or next to controls, fuses, circuit breakers, patching jacks, connectors, receptacles, terminal blocks, meters, indicators, switches, monitors, etc. The identification shall be directly engraved on Contractor-fabricated equipment and devices, clearly indicating the function of the items numbered or lettered to correspond with the function, circuit and locations, consistent with the Field and Shop Drawings.
E. Identification of fuses and circuit breakers on contractor fabricated equipment shall indicate:
   1. Protected circuitry.
   2. Rating of protective device.
   3. Voltage across open circuited protected device.
F. Design devices connected to the protected electrical system and auxiliary equipment necessary for the operation of the equipment associated with systems specified to operate from 105 to 130 volt, 60 Hertz, alternating current service, and with stable performance. Provide integral fuse or circuit breaker protection.
1. Provide Contractor fabricated items with fuses of the clear glass cartridge type and mounted in fuse holders that indicate when a fuse is blown or defective.

2. Locate protection devices to ease replacement, resetting, or observation of status without demounting the associated unit or de-energizing adjacent equipment.

G. Circuit components shall be operated according to recommendations of the component manufacturer and contain sufficient permanent identification to ease replacement.

H. Each principal element of each system shall be completely wired internally with consistently identified terminal strips provided for external connections. Indicate these designations on drawings where such connections are referenced and drawn.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not proceed with the work of this section until conditions detrimental to the proper and timely completion of the work have been corrected in an acceptable manner.

3.2 INSTALLATION

A. Verify exact locations of equipment with the District and A/E before installation and modifications to existing appendances and other trades necessary to provide a complete and operational system. Immediately notify the District and A/E of any discrepancies.

B. Coordinate work and service with the Contractor, electrical subcontractor, and the Districts scheduled use of facilities.

C. Coordinate final connection of power and ground wiring to equipment with electrical subcontractor. Power and ground wiring shall terminate inside sound rack and provide for interconnection to the building's electrical system.

D. Equipment and enclosures shall be plumb and square. Permanently attach equipment, except portable equipment, firmly in place to the structure. Supports shall be adequate to support their loads at a safety factor of three.

E. Supply completely assembled and fully shop-tested racks with internal wiring completed as required to provide a complete system.

F. Locate all apparatus requiring adjustments, cleaning, or similar attention to be accessible.

G. Supporting structures and enclosures not having a standard factory paint finish, shall be painted as directed by the A/E.

H. Match color and finish of blank panels and custom assembly panels to adjacent equipment panels to the extent possible.

I. Prevent and guard against electromagnetic and electrostatic hum.

J. Install equipment to provide safe operation.

K. Provide ventilation as required to maintain equipment within the manufacturer's specified temperature limits.
L. Provide cables necessary for interconnection of permanently mounted equipment. Use terminations required to achieve full function of equipment as specified.

M. Exercise care in wiring, to avoid damage to the cables and to the equipment. Make all joints and connections with resin-core solder or with mechanical connectors approved for Class I wiring. Execute all wiring in strict adherence to standard broadcast procedures.

N. Run lines in separate metallic conduits for:
   1. Microphone level circuits (up to -20 dBm).
   2. Line level circuits (up to +30 dBm).
   3. Loudspeaker circuits (above +30 dBm).
   4. Power circuits.

O. Grounding:
   1. Ground power conduits with heavy wire to the power system ground. Use only cables which are insulated from the conduit and from each other for the entire conduit length. Connect conduits mechanically and electrically to the sound system ground point. Do not splice lines in conduit.
   2. Ground audio cable shields only at the power amplifier inputs. Terminate shields at the “floating” end with insulating collars or heat shrink tubing. Preserve continuity of shields at connecting points. Connect all audio grounds in this system to a common point and the racks to a building earth cable sized for DC resistance of less than 0.1 ohm. For example, for a ground run of 15 feet, use No. 8 AWG conductor. Run ground conductor in conduit.

P. Coordinate sound equipment connections, panels, and control locations with A/E before installation.

Q. On completion, remove all rubbish and unused materials from the premises and clean the premises and all equipment where dirtied by removing all dirt, dust, stains and fingerprints.

R. Install assistive listening systems signage in all rooms and in all locations as required by ADA requirements.

S. Provide portable assistive listening systems to owner in original package with all manufacturer’s published installation, operation and maintenance manuals.

3.3 TESTING

A. Instrumentation:
   1. Furnish a listing of test equipment to be used for this project. Include make, model number, serial number and the date of last equipment calibration. Test equipment shall be calibrated within the past 24 months of award of this project’s contract
   2. Perform all tests and measurements as specified.
      a. Furnish equipment necessary to perform these tests and be prepared to repeat any or all tests as may be directed by the A/E during the period of final inspection and checkout.
      b. Perform work required to modify the performance of the system under provisions of this specification.
B. Electrical/Electronic Tests:

1. General Inspection and Adjustment:
   a. Measure and subsequently document individual components are performing
      under provisions of each manufacturer's published specifications.
   b. Examine frequency response, total harmonic distortion and signal-to-noise ratio.
   c. Calibrate, align, and equalize all meters, tape recorder heads, and record and
      playback equipment.
   d. Replace any components found to be defective.

2. Loudspeaker Line Impedance:
   a. Measure the impedance and the resistance of each loudspeaker line leaving the
      sound equipment racks with the line disconnected from its normal driving source.
   b. Maintain values within +10 percent of the value calculated for that circuit based
      upon the parallel impedances of the loudspeakers connected plus the resistance
      of the loudspeakers.
   c. Measure full-range loudspeaker impedance.

3. Hum and Noise Level:
   a. Measure the hum and noise levels of the overall system.
   b. Adjust gain controls for optimum signal-to-noise ratio for so full amplifier output is
      achieved with 0 dBm input.
   c. Terminate inputs with shielded resistors of 600 ohms for these measurements.
      1). Disconnect the loudspeaker lines and terminate the power amplifier outputs
         with power resistors for these measurements.
      2). Match rated load impedance and output power of the amplifiers.

4. Power Output and Signal Level Adjustments:
   a. Measure the electrical distortion of the overall system.
   b. Adjust gain controls as for the hum and noise level test.
   c. Set variable equalizers for flat response.
   d. Apply 1,000 Hz synovia signal at the input tested, at a level required to produce a
      full amplifier output.
   e. Use a distortion analyzer to measure the output level and total harmonic
      distortion of the amplification equipment.
   f. Make all measurements with loads actually incurred in system operation.
   g. Power Amplifier Loads: Resistors equal to the nominal impedance of the output
      terminals used in the system.

5. Freedom from Parasitic Oscillation and Radio-Frequency Pickup:
   a. Verify system is free from spurious oscillation and radio-frequency pickup, both in
      the absence of any audio input signal and also when the system is driven to full
      output at 100 Hz.
   b. Employ an oscilloscope as specified.

6. Loudspeaker Phasing:
a. Perform phasing checks of loudspeaker lines by means by a DC source at one end of each line and a voltmeter at the other end.

b. Phase all loudspeaker lines identically with respect to color coding.

7. Freedom from Buzzes, Rattles and Objectionable Distortion:
   a. Apply a slow synovia sweep from 50 to 5,000 Hz at a level 6 DB below rated power amplifier output voltage.
   b. Listen carefully for buzzes, rattles, and objectionable distortion.
   c. Correct any causes of these defects, unless the cause is clearly outside the sound amplification system equipment and installation, in which case, the cause shall be brought to the attention of the A/E.

8. Gain Control Settings:
   a. Establish tentative normal settings for all gain controls.
   b. Adjust all gain controls on rack-mounted equipment for optimum signal-to-noise ratio and signal balance.
   c. Settings may require further adjustment by the Contractor as a result of testing by the A/E.
   d. After final gain and attenuator settings have been established, mark all control settings with an adhesive indicator dot or arrow.

9. Freedom from Switching Transient Noise:
   a. Operate all control switches and relays and eliminate clicks and pops found in the system outputs.

10. Listening Test: Listen to normal program material to be sure that there are no remaining defects.

C. Acoustical Tests:
   1. Make necessary adjustments to ensure proper operation of the system.
   2. The overall space average acoustical frequency response within each area served shall be within the limits specified.
   3. Test signals shall be broad band "pink" noise applied to any system input. Measurements shall be made using 1/3 octave band filters centered on ANSI preferred frequencies.
   4. Throughout the coverage area of the system, amplified sound levels shall not vary more than + 3 DB as measured using an octave band of "pink" noise centered at 4,000 Hz as the test signal.
   5. Measurements of system performance will be made using a calibrated ANSI S1.4, Type I sound level meter set for "slow" meter damping and flat response.
      a. Position microphone 4 feet above the floor within the area served by the system.
      b. Interior finishes and furnishings shall be in place and the system gain be set to provide octave band levels at least 10 DB above background noise levels in any octave band at the measuring locations for these tests.

D. Report.
1. Upon completion of tests and any necessary adjustments, submit 2 copies in written report presenting test results, including numerical values where necessary, for review by the A/E before acceptance testing, final tuning, and demonstration.

2. Include written certification that the installation conforms to the requirements stated, is complete in all respects, and is ready for inspection, testing, and final tuning.

3.4 DEMONSTRATION OF EQUIPMENT OPERATION

A. General:
   1. Upon approval of the test report by the A/E, and at a time established by A/E, demonstrate the operation of each major component of the system and the completed installation. After demonstration, assist as required in the following acceptance tests:
      a. Listening Tests: These tests may include speech intelligibility survey and subjective aural evaluations by observers at various positions under various operating conditions, using live speech and recorded music material.
      b. Equipment Tests: Any measurements of frequency response, distortion, noise or other characteristics and any operational tests deemed necessary may be performed on any item or group of items to determine conformity with these requirements.

2. If the need for adjustment or modification becomes evident during demonstration and testing, continue working until the installation operates fully under provisions of the requirements of this specification.

B. Maintenance Information:
   1. Provide technical information for all electronic apparatus, including but not limited to schematic diagrams and parts lists, manufacturer's installation instructions, operating instructions, and technical specifications.

2. Include shop drawings prepared and used for installation, and those not required to be submitted for approval. This includes, but is not limited to, wiring diagrams, schedules for identification of building wiring and installation details useful to maintenance technician.

C. Instruction Manuals:
   1. Provide 5 copies of an instruction manual containing the following:
      a. Table of contents.
      b. Instructions for operating the system in all modes of operating and for fulfilling all functional requirements.
      c. Lists of settings and adjustments for semi-fixed controls.
      d. Manufacturer's sheets of specifications, operating instructions, and service information arranged alphabetically by manufacturer and then by model number.
      e. Detailed wiring diagrams and the simplified one-line diagram.

3.5 TRAINING AND INSTRUCTION

A. Provide a minimum of 4 hours of training to the District's designated representatives, at a time mutually agreed upon with the District. Contractor shall notify A/E of date and time
established for training and instruction. Training shall include set up, operation and test of system for proper performances.

B. During the training give the participants opportunities for "hands-on" experience with operating the controls. Provide visual and audible demonstrations using the systems themselves as aids.

C. Training shall demonstrate how to set-up, operate, and test system for proper function.

END OF SECTION 27 51 21
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Wireless Master clock control unit.

1.3 DEFINITIONS

A. NIST: The National Institute of Science and Technology.
B. PC: Personal computer.
C. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude; a worldwide standard for time synchronization.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:
   1. Master unit.
   2. Indicating clocks.
   3. Equipment enclosures and back boxes.
   4. Accessory components.

B. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring and correction circuits.
      a. Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
      b. Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Show protection from overcurrent, static discharge, and voltage surge.

C. Field quality-control reports.

D. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.
1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MASTER AND SECONDARY CLOCK SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Teradon, battery operated wireless clocks compatible with the existing campus system. Provide clocks complete with Duracell batteries. Teradon clocks are district standard and substitutions will not be allowed.

B. System Functions and Features:

1. Maintain correct synchronized time and transmit time-correction signals from a master clock to secondary indicating clocks, including the following:
   a. Analog Battery Clocks: Correct for minute- and second-hand synchronization.

2. Provide for manual control of programmed signal and equipment-switching circuits.

3. Maintain system access security to restrict use of system controls to authorized personnel. Access to user programming and control functions is accomplished by entering a minimum three-digit code. Access levels include the following:
   a. Access to review existing programs only.
   b. Access to normal system operating controls.
   c. Access to all user-programming and control functions.

4. Automatically check functioning of LEDs, switches, input keys, central processor, read-only memory, random access memory, and output circuits. A display on the control panel shall indicate failure by identifying faulty component or circuit and shall recommend corrective action.

5. Provide programming for automatic daylight savings time correction.

6. Provide wireless Transmitter/Repeaters as necessary for a completely operating system.

7. Provide Master Clock with GPS input module.

8. Provide Master Clock with Web interface software to allow configuring settings via a simple we interface.

2.2 WIRELESS MASTER CLOCK

A. Description: Microprocessor-based, software-controlled unit complying with Class A device requirements in 47 CFR 15. Provide ThreeSixty TIMA-2SO-1100-1 with TIMA-200-WEBI-0. Provide one (1) Wireless Master Clock per building.

1. Programming and control switches.

2. Informational Display: LED or backlit LCD type.
   a. Normally shows current time display.
   b. Provides programming cues when system is being programmed.
3. Output for Correction of Wireless Secondary Indicating Clocks:

4. Data Output Port: RS485 or similar circuit for scheduled periodic correction signals.

5. PC interface software suitable for remote programming.

6. Enclosure: Metal cabinet with locking front panel. When cabinet is locked, display indication shall be visible on or through front panel face. Arrange cabinet for surface, mounting as indicated.

7. Battery Backup for Time Base: Lithium battery to maintain the timekeeping function and retain the programs in memory during outage of normal ac power supply for up to 10 years.

8. Electrostatic Discharge Resistance: Master clock shall be tested and certified according to IEC 61000-4-2 in both human-discharge and direct-injection modes.

2.3 WIRELESS SECONDARY INDICATING CLOCKS


B. Correction receiving and transmission rates:
   1. Every two hours for normal mode battery operation
   2. Every four hours for economy mode battery operation.

C. Secondary Indicating Clock Characteristics:
   1. Clock Type: Analog.
   2. Face Configuration: Single.
   7. Analog Clock Crystal: Clear polycarbonate.
   10. Seconds Display: Yes.
   12. Interval-Timer Display: No.

2.4 GUARDS

A. Description: Formed-steel wire, shaped to fit around guarded device, with 1-inch maximum clearance.
   2. Finish for Indoor Devices: Clear epoxy lacquer over zinc plating.
   3. Provide guards on all clocks in gymnasium, locker rooms and team rooms.
PART 3 - EXECUTION

3.1 INSTALLATION
A. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.2 WIRING METHODS
   1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 ELECTRICAL CONNECTIONS
A. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION
A. Comply with Division 26 Section "Identification for Electrical Systems."
B. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

3.5 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.
B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
C. Tests and Inspections:
   1. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
   2. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
D. Clock system will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.
3.6 ADJUSTING

A. Program system according to Owner's requirements. Set system to operate on Owner-required schedules and are activated for durations selected by Owner. Program equipment-control output circuits to suit Owner's operating schedule for equipment controlled.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

END OF SECTION 27 53 13
DIVISION 28
ELECTRONIC SAFETY AND SECURITY
SECTION 28 00 00

BASIC SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for Division 28 and is intended to supplement, not supersede, the requirements specified in Division 1.

B. The requirements described herein include the following:
   1. References
   2. Definitions
   3. System Description
   4. Submittals
   5. Quality Assurance
   6. Project Management and Coordination Services
   7. Product Delivery, Storage, and Handling
   8. Warranty
   9. Maintenance

C. Products furnished and installed under another section:
   1. 120V power
   2. Conduit and junction boxes
   3. Door hardware
   4. Network Connections

D. Related Sections:
   1. Consult other Sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable installation.
   2. Section 28 05 13 – Security System Cabling
   3. Section 28 05 53 – Security System Labeling
   4. Section 28 08 00 – Security System Acceptance Testing
   5. Section 28 13 00 – Access Control and Alarm Monitoring System
   6. Section 28 16 00 – Intrusion Detection System
   7. Section 28 23 00 – Video Surveillance System
   8. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, and bollard foundations.
   9. Selective Demolition: Nondestructive removal of materials and equipment for reuse or salvage as indicated. Also dismantling electrical materials and equipment made obsolete by these installations.
10. Concrete Work: Include forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, pedestal foundations, and curbs (also includes saw-cutting of existing slabs and grouting of conduits in saw-cut).

11. Miscellaneous Metal Work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, equipment enclosures, cameras, and similar devices.

12. Miscellaneous Lumber and Framing Work: Include wood grounds, nailers, blocking, fasteners, and anchorage for support of security materials and equipment.

13. Moisture Protection and Smoke Barrier Penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. Tape and make vapor tight penetrations through vapor barriers at slabs on grade.

14. Locking Hardware: Include interface to electronic hardware and door controllers on security related doors.

15. Access Panels and Doors: Required in walls, ceilings, and floors to provide access to security devices and equipment.

16. Painting: Include surface preparation, priming and finish coating as required for security cabinets, exposed conduit, pull and junction boxes, and devices where indicated as field painted in this Division. Refer to Division 9, Painting.

17. Elevators: Include interface to elevator floor and hall call on security related elevators.

1.2 REFERENCES

A. General

1. Codes, standards, and industry manuals/guidelines listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Consider such codes and/or standards a part of this Specification as though fully repeated herein.

2. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

3. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid unless otherwise specifically stated.

B. Codes: Perform Work executed under this Section in accordance with applicable requirements of the latest edition of governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:

1. California Code of Regulations (CCR):
   a. Title 8, “Industrial Relations”
      1) Chapter 3.22, “California Occupational Safety And Health Regulations (CAL/OSHA)”
   b. Title 24, “California Building Standards Code”
2) Part 2, Volumes 1 and 2, “California Building Code” (CBC)
3) Part 3, “California Electrical Code” (CEC)
4) Part 11, “California Green Building Standards Code” (CALGreen)

2. National Fire Protection Agency (NFPA)
   a. NFPA 70, “National Electrical Code” (NEC)
   b. NFPA 75, “Protection Of Information Technology Equipment”

3. National Fire Protection Agency (NFPA)
   a. NFPA 70, “National Electrical Code” (NEC)
   b. NFPA 75, “Protection of Information Technology Equipment”

4. International Code Council

5. National, State, Local and other binding building and fire codes

   a. Part 15, Radio Frequency Devices

C. Standards: Perform Work and furnish materials and equipment under Division 137xx in accordance with the latest editions of the following standards as applicable:

1. Underwriter’s Laboratories (UL): Applicable listing and ratings.
   a. UL 294: Access Control System Units
   b. UL 1076: Proprietary Burglar Alarm Units and Systems
   c. UL 2044 Commercial Closed-Circuit Television Equipment

1.3 DEFINITIONS

A. The Definitions of Division 1 apply to the 28xxxx sections

B. In addition to those Definitions of Division 1, the following list of terms as used in this specification defined as follows:

1. “Owner”: Contra Costa Community College District
2. “Engineer”: TEECOM Design Group
3. “Furnish”: To purchase, procure, acquire, and deliver complete with related accessories.
4. “Install”: To set in place, join, unite, fasten, link, attach, set up or otherwise connect together and test before turning over to the Owner, parts, items, or equipment supplied by contractor or others. Complete installation and make ready for regular operation.
5. “Provide”: To furnish, transport, install, erect, connect, test and turn over to the Owner, complete and ready for regular operation.
6. "Connect": To install required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.

7. "As directed": As directed or instructed by the Owner, or their authorized representative.

8. "Cabling": A combination of cables, wire, cords, and connecting hardware (e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling).

9. "System": The access control, video surveillance, and intrusion detection systems

10. "SEC": Security Equipment Cabinet

11. "SJB": Security Junction Box

12. "ACAMS": Access Control & Alarm Monitoring System

13. "VSS": Video Surveillance System

14. "IDS": Intrusion Detection System

1.4 SYSTEM DESCRIPTION

A. Overview

1. The Owner intends to renovate multiple buildings at Contra Costa College.

2. Security at the modernized facility will consist of video surveillance, access control and alarm monitoring, and intrusion detection systems.

3. The System will connect to the Owner's existing Software House CCure 9000 headend located at the District Office over the Owner's local/wide area network.

4. Provide a high level of coordination services to ensure the proper installation and functioning of the security system.

5. Coordinate the installation of the security system with other trades. This may include: review of other's subcontractor's shop drawings, attendance at meetings, providing samples for mockup, and preparation & distribution of written documentation.

6. Refer to Division 1 for detail building description.

B. Base Bid Work

1. Access Control and Alarm Monitoring System (ACAMS)
   a. The Owner requires an access control system to automate opening and closing of the building, restrict access after hours by cardholder privileges, and monitor specific spaces for intrusion.
   b. The ACAMS consists of card readers, control panels, power supplies, workstations, alarm monitoring devices, and interfaces to other security equipment.
   c. Refer to Section 28 13 00 for detailed description of system.

2. Intrusion Detection System (IDS)
   a. The IDS consists of keypads, control panels, duress buttons, alarm monitoring devices, and interfaces to other security equipment.
   b. The IDS will communicate with a remote, third-party central station for alarm monitoring and contact Police Services during day-time operation and dispatch of the local Police Department after hours.
   c. Refer to Section 28 16 00 for detailed description of system.
3. Video Surveillance System (VSS)
   a. The Owner requires a video surveillance to provide a photographic record of access control transactions and alarm events, some real-time monitoring of the facility, and integration with the access control and alarm monitoring system.
   b. The VSS consists of a combination of analog and IP cameras, power supplies, IP encoders, and network video recorders.
   c. Refer to Section 28 23 00 for detailed description of system.

4. The System includes integration with the Fire/Life-Safety system to provide the following:
   a. Automatically release locks upon fire alarm activation for doors within the path of egress
   b. Disconnect power to magnetic door holders to automatically close doors after business hours

1.5 SUBMITTALS

A. Submit required submittals to the General Contractor in the quantities and formats as required under the general contract. In the absence of requirements, provide as described in the following with reference to quantity and format.

B. Contractor Qualifications
   1. Resumes of the Project Manager, General Foreman, and Lead Technician(s) indicating role, years of experience, product certifications and training, listing of similar projects the individual performed the role proposed for this project along with client contact information for each.
   2. Certification letters stating the Contractor is an authorized reseller, installer, and extended warranty provider for the following systems:
      a. Software House CCure 9000
      b. Salient Systems

C. Product Data
   1. Obtain written approval from the Engineer for the product data submittal prior to the release of materials and equipment purchase order and prior to installation.
   2. Quantity: Submit product data submittals as described in Division 1.
   3. Format:
      a. Minimum Format: Submit each product data submittal in an 8-1/2 x 11 inch folder. Product data submittal shall be in a 3-ring binder (or similar). If in a 3-ring binder, insert the submittal information the transparent front cover and spine pockets.
      b. Clearly label the cover and spine of each submittal with the following information:
         1) Client Name
         2) Project Name and Address
         3) Project Submittal Number
         4) Submittal Name (e.g., “Product Data Submittal for Video Surveillance System”)
         5) Specification Section Number (e.g., “Section 28 23 00”)
         6) Date of Submittal Format: <month> <day>, <year> (e.g., “January 1, 2010”)
7) Contractor Name
   c. Include a Table of Contents at the beginning of the submittal that lists materials by article and paragraph number (e.g., “2.02-A Network Video Recorders”).
   d. Include tabbed separators for improved navigation through the submittal.

4. Content:
   a. Cover Letter: Product data submittals shall include a cover letter stating that the submittal is in full compliance with the requirements of the Contract Documents. Sign (and stamped, if applicable) cover letter and list items and data submitted. Have the person who prepared the submittal sign the document as well. Failure to comply with this requirement shall constitute grounds for rejection of submittal.
   b. Product Information: Product Data submittal shall consist of manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary). This data shall clearly describe the product’s characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded. At a minimum, include products listed in the Division 28 specifications. Include relevant products that will be installed, which are not listed in the specifications.
   c. Re-submittals: Provide a cover letter with the re-submittal that lists the action taken and revisions made to each product submittal in response to Submittal Review Comments. No review shall take place for any re-submittal packages that is not accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the re-submittal package.

D. Shop Drawings
   1. Obtain written approval from the Engineer for the shop-drawings submittal prior to the release of materials and equipment purchase order and prior to installation.
   2. Quantity and Media: Submit shop-drawings as described in Division 1.
   3. Format:
      a. Produce shop drawings using AutoCAD, or other computer design application that can save files to AutoCAD-compatible files.
      b. Use the same size drawing sheet as the drawings of the Contract Documents.
      c. Text: minimum of 3/32" high when plotted at full size.
      d. Screen background information.
      e. Plot system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.
      f. Scaling:
         1) Scale floor plans at 1/8"=1'-0"
         2) Scale enlarged room plans at 1/4"=1'-0"
         3) Scale wall elevations at 1"=1'-0"
   4. Content:
a. Submit shop drawings that represent proposed installation of security system.

b. Floor Plans: Scale floor plans at 1/8"=1'-0". Floor plans shall show:
   1) Locations and identifiers of security devices.
   2) Size, quantity, location and proposed routes of security cabling.
   3) Size, quantity, location, and routes of pathways (such as cable trays, cable basket, conduits, cable hangers, and other cable support devices).

c. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices.

d. Schedules: Provide schedules for devices and control panels that show each point ID with a description of the connected devices.

e. Block Diagram/Riser Diagram: Show the devices, conduit, wire types, and sizes between them, including cabling interties between termination hardware.

f. Proposed mounting details

E. As-Built Drawings

1. Quantity and Media: Submit as-built drawings as described in Division 1 in both hard copy and electronic formats.

2. Format:
   a. Produce as-built drawings using AutoCAD, or other computer design application that can save files to AutoCAD-compatible files.
   b. Use the sheet size as the drawings of the Contract Documents, and use the project title block.
   c. Text: minimum of 3/32" high when plotted at full size.
   d. Use symbols identical to the symbols shown on the Drawings.
   e. Screen background information.
   f. Plot system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.

3. Content:
   a. Submit as-built drawings that fully represent actual installed conditions and that incorporate modifications made during the course of construction.
   b. Floor Plans: Scale floor plans at 1/8"=1'-0". Floor plans shall show:
      1) Locations and identifiers of security devices.
      2) Size, quantity, location and proposed routes of security cabling.
      3) Size, quantity, location, and routes of pathways (such as cable trays, cable basket, conduits, cable hangers, and other cable support devices).
   c. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices.
   d. Schedules: Provide schedules for devices and control panels that show each point ID with a description of the connected devices.
   e. Block Diagram/Riser Diagram: Show the devices, conduit, wire types, and sizes between them, including cabling interties between termination hardware.
   f. Custom mounting details
F. Operation and Maintenance (O&M) Manuals
   1. Quantity: Submit quantity of O&M Manuals as described in Division 1 in both hard copy and electronic formats.
   2. Format:
      a. Submit each O & M Manual in a white, 3-ring binder with front cover and spine clear pockets for insertion of the project information.
      b. Clearly label the cover of each O&M Manual with the following information:
         1) Client Name
         2) Project Name and Address
         3) Manual Name (e.g., "Operation and Maintenance Manual for Telecommunications Cabling System")
         4) Date of Submittal Format: <month> <day>, <year> (e.g., "January 1, 2010")
         5) Contractor Name
      c. Include a Table of Contents at the beginning that lists the contents.
      d. Include tabbed separators for improved navigation through the manual.
   3. Content:
      a. 11"x17" prints of as-built drawings, as described above
      b. Manufacturer's original catalog information sheets for each component provided under applicable Section (typically, this is similar to the accepted product data submittal)
      c. Warranty certificate from the manufacturer and the Contractor
      d. Manufacturer's instructions for system or component use
      e. Instructions and requirements for maintenance and warranty issues
   4. Contents shall include requirements and methods for maintaining installed products.

1.6 QUALITY ASSURANCE

A. General
   1. Provide new and unused materials, equipment, and parts comprising the units specified herein of current manufacturer and of highest grade.
   2. Only use products and applications listed in this Division on the project

B. Substitutions
   1. Conform to the general requirements and procedure outlined in Division 1 in the Request For Substitution.
   2. Where products are noted as "or equal", a product of equivalent design, construction, and performance is considered. Include in the Product Data submittal: catalog cuts, product information, and pertinent test data required to substantiate that the product is in fact equivalent to that specified.
   3. Only one substitution allowed for each product specified. Do not provide substituted material, processes, or equipment without written authorization from the Engineer. Assumptions on the acceptability of a proposed substitution, prior to acceptance by the Engineer, are at the sole risk of the Contractor.
4. The burden of proof rest with the Contractor that the substituted product is equivalent to
the specified product. When the Engineer accepts a substitution in writing, it is with the
understanding that the Contractor guarantees the substituted product, component,
article, or material to be equivalent to the one specified and dimensioned to fit within the
construction according to contract documents. Approved substitutions do not relieve the
Contractor of responsibilities for the proper execution of the Work, or from provisions of
the Specifications.

5. Manufacturers' names and model numbers used in conjunction with materials,
processes or equipment included in the Contract Documents are used to establish
standards of quality, utility and appearance. Materials, processes or equipment that, in
the opinion of the Engineer, are equivalent in quality, utility and appearance will be
approved as substitutions to that specified when "or equal" follows the manufacturers'
names or model number(s).

6. Whenever material, process or equipment is specified in accordance with a Federal
specification, an ASTM standard, an ANSI specification, UL rating or other association
standard, present an affidavit from the manufacturer certifying that the product complies
with the particular standard specification. When requested by the Engineer, submit
support test data to substantiate compliance at no additional cost.

7. Pay expenses, without additional charge to the Owner, in connection with substitution
materials, processes and equipment, including the effect of substitution on self,
subcontractor's or other Contractor's work.

C. Contractor Qualifications
   1. A current, active, and valid and C7 or C10 California State Contractors License
   2. Minimum five years experience in installation and service of access control, video
      surveillance, and intrusion detection systems.
   3. Minimum five completed projects similar to scope and cost.
   4. Evidence of technicians qualified for the work in the form of current manufacturer’s
      training certification

D. Materials
   1. Materials, support hardware, equipment, parts comprising units, etc., shall be new,
      unused, without defects and of current manufacturer, materials
   2. Use specified products and applications, unless otherwise submitted and approved in
      writing.

E. Regulatory Requirements
   1. Work and materials shall conform to the latest rules of National Board of Fire
      Underwriters wherever such standards have been established and shall conform to the
      regulations of the State Fire Marshal, OSHA and the codes of the governing local
      municipalities. Work under Division 28 shall confirm to the most stringent of the
      applicable codes.
   2. Provide the quality identified within these Specifications and Drawings when codes,
      standards, regulations, etc. allow Work of lesser quality or extent. The Contract
      Documents address the minimum requirements for construction.
F. Drawings
   1. Follow the general layout shown on the Drawings except where other work may conflict with the Drawings.
   2. Drawings for the Work within this Division are essentially diagrammatic within the constraints of the symbology applied.
   3. The Drawings do not fully represent the entire installation for the security system. Drawings indicate the general route for the cables and the location of outlets. The Drawings might not expressly show every conduit, sleeve, hanger, etc., but a complete system is required.
   4. Complete the details necessary for point-to-point design. This allows the Contractor to achieve desired results applying their own procedures and methods. Submit shop drawings for review prior to installation.

1.7 PROJECT MANAGEMENT AND COORDINATION SERVICES

A. Project Management and Coordination Services
   1. Provide a project manager for the duration of the project to coordinate this Work with other trades. Coordination services, procedures and documentation responsibility include, but are not limited to, the items listed in this section.
   2. Review of Shop Drawings Prepared by Other Subcontractors:
      a. Obtain copies of shop drawings for equipment provided by others that require telecommunication service connections or interface with Work.
      b. Perform a thorough review of the shop drawings to confirm compliance with the service requirements contained in the Division 28 contract documents. Document discrepancies or deviations as follows:
         1) Prepare memo summarizing the discrepancy
         2) Submit a copy of the specific shop drawing, indicating via cloud, the discrepancy
      c. Prepare and maintain a shop drawing review log indicating the following information:
         1) Shop drawing number and brief description of the system/material
         2) Date of the review
         3) Name of the individual performing the review
         4) Indication if follow-up coordination is required
   3. Request for Information (RFI)
      a. Thoroughly review the contract documents prior to the preparation and submission of an RFI. If an RFI is submitted, attach 8 1/2" x 11" copies of relevant documents to clarify the issue.
      b. Submit RFIs with your recommended solution.
      c. Prepare and maintain an RFI log using a Microsoft Excel spreadsheet indicating the following information:
         1) RFI number and brief summary of the issue.
         2) Date of issuance and receipt of response.
   4. Scheduling of Work
      a. Prepare work schedules for each floor or building indicating the following information:
1) Cable Installation
2) SEC Build Out
3) Device Installation
4) Programming
5) Testing
6) Other tasks included under the alternate work section of these specifications

B. Role of the Engineer
1. During the construction phase of the project, the Engineer will work with the Contractor to provide interpretation and clarification of project contract documents, reply to (and 'process') relevant Requests for Information (RFIs), and act as an interface between the Contractor and the Owner.
2. The Owner has retained the Engineer’s services to observe the Work for general compliance with the Contract Documents and to ensure that the installation meets the design intent of the system.
3. In general, the Engineer will participate during the construction phase as follows:
   a. Review product data and shop drawings submittals for general compliance with the contract drawings and specifications.
   b. Review changes as they arise, and confirm that the proposed solutions maintain the intended functionality of the system.
   c. Interpret field problems for Owner, and translate between Owner and Construction Team.
   d. Review the testing procedures to confirm compliance with industry-accepted practices.

C. Use of CAD Files
1. Should the Contractor need the Engineer’s CAD files to produce shop drawings and/or as-built drawings, the Engineer requires the Contractor sign a CAD files release agreement.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery
1. Do not deliver security system components to the site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable.
2. Replace equipment damaged during shipping and return to manufacturer at no cost to the Owner.

B. Storage
1. Store materials in a clean, dry, ventilated space free from temperature extremes.
2. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
3. Provide heat where required to prevent condensation or temperature related damage.

C. Handling
1. Handle in accordance with manufacturer’s written instructions.
2. Prevent internal component damage, breakage, denting and scoring. Do not install damaged equipment. Replace damaged equipment and return equipment to manufacturer.

1.9 WARRANTY

A. Provide the Security System as described in this specification with a one-year parts and service warranty at no additional cost to the Owner.

B. Include in the warranty package, at a minimum, the following:
   1. Software support agreement for the ACAMS and VSS
   2. Software upgrades and patches
   3. Labor to install software upgrades and patches necessary to maintain the latest version
   4. Emergency service on regular working hour basis
   5. Service by factory trained and employed service representatives of system manufacturer

C. Maintain regular service facilities and provide a qualified technician familiar with this work at the site within four (4) hours of receipt of a notice of malfunction including weekends and holidays. Provide material, devices equipment and personnel necessary for repairs. Install approved temporary, alternate equipment if required by the Owner, complete and operational within twenty four (24) hours after notification of a malfunction, at no additional cost.

D. Conduct warranty repairs and service at the job site unless in violation of manufacturer's warranty; in the latter event, provide substitute systems, equipment and/or devices, acceptable to the Owner, for the duration of such off-site repairs. Transport warranty substitute and/or test systems, equipment, devices, material, parts and personnel to and from the job site at no additional cost.

1.10 MAINTENANCE

A. Extra Materials
   1. Deliver extra materials to a secured location determined by the Owner.
   2. Provide a complete Bill of Materials listing quantities, part numbers, and descriptions for each device for the Owner to sign indicating receipt of equipment.
   3. Provide new and unused spare parts in their original packing materials upon delivery.

B. Maintenance Service
   1. For the first year of service, conduct quarterly system performance review meetings to review system operation problems and/or defects that occurred during the preceding 3 months. During these performance review meetings, perform the following:
a. Visual checks and operational tests of the central processor, local processors, monitors, keyboards, system printers, peripheral equipment, ACAMS equipment, power supplies, and electrical and mechanical controls
b. Clean system equipment, including interior and exterior surfaces
c. Perform diagnostics on equipment
d. Check and calibrate each device
e. Run system software and correct diagnosed problems
f. Resolve previous outstanding problems
2. Provide software and firmware updates issued free of charge by the manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL

A. Material and equipment specified herein have been selected as the basis of acceptable quality and performance and have been coordinated to function as components of the included systems. Where a particular material, device, equipment or system is specified directly, the current manufacturer’s specification for same is a part of these specifications, as if completely elaborated herein.

B. Remove manufacturer identification marks from visible equipment.

C. Use standard, regularly manufactured, materials and equipment for this and/or other similar systems, and not custom designed especially for this project. Provide systems and components thoroughly tested and proven in actual use. Provide subsystems of one manufacturer.

2.2 TAMPER RESISTANT HARDWARE

A. Provide pinned-Allen type hardware for exposed hardware in public spaces.
   1. Provide hardware used in specialty metal surfaces that possess a similar finish color.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Conditions: Verify existing conditions, which have been previously provided under other sections, are acceptable for product installation in accordance with manufacturer’s instructions.

B. Pathways: Verify that pathways and supporting devices, which have been previously provided under other sections, are properly installed, and that temporary supports and devices have been removed.

C. Field Measurements: Verify dimensions of pathways, including length of pathways. For example, “True Tape” the conduits to verify cable distances.

3.2 FIELD QUALITY CONTROL

A. Staffing: Provide a qualified foreman who is in charge of the Work and who is present at the job site at times Work is being performed. Perform the Work using skilled technicians under
the direction of the foreman. Supervise the work force executing the Work. Perform the installation within the restraints of the construction schedule. Do not change the supervisor during the project without prior written approval from the Owner.

B. Inspection: Perform inspection after installation. Keep areas of work accessible and notify code authorities, or designated inspectors, of work completion released for inspection. Document completion, and inspection as required.

3.3 INSTALLATION

A. Perform this work in accordance with acknowledged industry and professional standards and practices and the procedures specified herein.

B. Provide a complete, operating system. Include devices specified including basic components and accessories, interconnecting wiring and other equipment and installation devices necessary for a complete system as specified.

C. Manufacturer's Instructions:
   1. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.
   2. Maintain jobsite file of Material Safety Data Sheets (MSDS) for each product delivered to jobsite.

D. Boxes, Panels, and Enclosures
   1. Install boxes, panels, and enclosures square and plumb.
   2. Set "flush mounted" units with the face of the cover, bezel or escutcheon in the same plane as the surrounding finished surface.
   3. Mount boxes, panels and trim so that there are no gaps, cracks or obvious lines between the trim and the adjacent finished surface and ready them to receive final finish, as applicable.
   4. Install insulating terminations in signal circuit boxes, panels, wireways or enclosures.

E. Painting
   1. Custom paint devices as indicated on the drawings.

3.4 REPAIR/RESTORATION

A. Replace or repair work completed by others that you deface or destroy, at no cost to the Owner.

B. Punch List:
   1. Inspect installed work in conjunction with the General Contractor and develop a punch list for items needing correction.
   2. Provide punch list to Engineer for review prior to performing punch walk with the Engineer.

C. Re-Installation:
   1. Make changes to the system such that defects in workmanship are correct and cables and the associated termination hardware passes the minimum test requirements.
   2. Repair defects prior to system acceptance.
D. Painting: Repaint surfaces altered during installation of the security system to match previous conditions.

3.5 CLEANING

A. Remove temporary coverings and protection of adjacent work areas. Remove unused products, debris, spills, or other excess materials. Remove installation equipment.

B. Leave finished work and adjacent surfaces in neat, clean condition with no evidence of damage.

C. Repair or replace damaged installed products.

D. Legally dispose of debris.

E. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.

END OF SECTION
SECTION 28 05 00

COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Electronic safety and security equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   5. Common electronic safety and security installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

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

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working security system installation, as described in these specifications.

B. Section Includes:
   1. Wire and cable
   2. Compression Seal BNC Connectors

C. Related Sections:
   1. Consult other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
   2. Section 28 00 00 – Basic Security Requirements: includes general project requirements, submittal formats, installation, and warranty requirements.
   3. Section 28 05 53 – Security System Labelling: includes label types and formats.
   4. Section 26 05 33 – Raceways and Boxes: includes pathway types in different areas of the project.

1.2 SUBMITTALS

A. Product Data: Submit product information, including:
   1. Cable Description and Use
   2. Jacket Rating
   3. Outside Diameter (of the overall wire or cable)
   4. Manufacturer and Part Number

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. General
   1. Provide required wire and cable sized to allow for voltage drop on long runs and effectively shielded as required to allow the routing of 12 & 24V power and video signal cable in the same conduit without interference or signal noise.
   2. Cable installed outdoors or in underground conduit must contain a PVC or Polyethylene jacket to prevent water intrusion and compliant with the TIA-455-82B water infiltration test.
   3. Cables installed indoors to contain a plenum rated jacket (type CMP).
B. Manufacturers:
   1. West Penn
   2. Belden
   3. Or Equal

C. Access Control & Alarm Monitoring System
   1. Plenum Jacketed Cable
      a. #18/2 AWG unshielded: West Penn #25224B, door contact cable
      b. #18/4 AWG unshielded: West Penn #25244B, REX and alarm device cable
      c. #18/6 AWG shielded (overall): West Penn #253186B, card reader cable
      d. #16/2 AWG unshielded: West Penn #25225B, lock power cable
      e. #14/2 AWG unshielded: West Penn #25226B, lock power cable from local power booster to exit device
      f. #24/4 AWG shielded (overall): West Penn #D4854, RS-485 communications cable
   2. Water Blocked Cable
      a. #18/2 AWG unshielded with Aquaseal tape: West Penn #AQC224, door contact cable
      b. #18/4 AWG unshielded with Aquaseal tape: West Penn #AQC244, REX and alarm device cable
      c. #18/6 AWG shielded (overall) with Aquaseal tape: West Penn # AQC3186, card reader cable
      d. #16/2 AWG unshielded with Aquaseal tape: West Penn #AQC225, lock power cable
      e. #14/2 AWG unshielded with Aquaseal tape: West Penn #AQC226, lock power cable from local power booster to exit device

D. Intrusion Detection System
   1. Plenum Jacketed Cable
      a. #22/2 AWG unshielded: West Penn #25221B, door contact cable
      b. #22/4 AWG unshielded: West Penn #25241B, keypad and alarm device cable
      c. #18/2 AWG unshielded: West Penn #25224B, control panel power cable

E. Video Surveillance System
   1. Cabling for IP cameras provided by Telecommunications contractor. Refer to Section 27 15 00 – Communications Horizontal Cabling.
   2. Provide minimum RG-59/U CCTV video coaxial cable between analog cameras and the monitoring equipment, with the following features:
      a. 95% percent copper braid
      b. Foam dielectric
      c. Solid copper core
      d. 75 ohm characteristic impedance
      e. Plenum jacket
   3. Plenum Jacketed Cable
2.2 MISCELLANEOUS COMPONENTS

A. Cable Ties

1. General
   a. Provide Velcro-style cable ties on security cabling within telecommunications spaces and covered wireways.
   b. Dress and bind cabling with cable ties every 24” minimum.
   c. Width: 0.75 inches
   d. Color: Black

2. Manufacturer:
   a. Panduit #HLS-15-R-0 Black, 15 feet roll, cut to length
   b. Or Equal

B. Compression Seal BNC (Bayonet Neill Concelman) Connectors

1. General
   a. Suitable for use on RG-59/U coaxial cable for CCTV systems.
   b. Compression seal connection
   c. Capable of accepting cable with outside diameters between 0.195 - 0.245 inches. Twist-on or crimp-on style connectors are not permitted.

2. Manufacturer:
   a. GEM Electronics #302-10CSTP compression seal BNC connector
   b. Or Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Label cables in accordance with Section 28 05 53 – Security System Labeling.

B. Horizontal Cable Installation and Routing

1. Provide wire and cable with a continuous, splice-free sheath for the entire length of run between designated connections or terminations. Splices not permitted.
2. Place cables within designated pathways, such as cable tray, basketway, cable hangers, etc. Do no fasten (such as with cable ties) or attach cables to other building infrastructure (such as ducts, pipes, conduits, etc), other systems (such as ceiling support wires, wall studs, etc), or to the outside of conduits, cable trays, or other non-approved pathway systems.

3. Place and suspend cables and conductors during installation and termination in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation or termination at no additional cost.

4. Route cables at 90-degree angles, allowing for bending radius, along corridors for ease of access.

5. Do not exceed manufacturer's limits for pulling tension.

6. Do not use cable-pulling compounds for indoor installations.

7. Route cables under building infrastructure (such as ducts, pipes, conduits, etc) so the installation results in easy accessibility to the cables in the future. Do not route cables over building infrastructure.

8. Dress and secure coaxial cables to preclude stress and/or deformation.

9. Install shielded wiring or route in separate raceways as recommended by the manufacturer's current requirements.

10. Place cables 6", minimum, away from power sources to reduce interference from EMI.

11. Do not run signal wire and cable in parallel to power (120VAC).

12. Make connections to screw-type barrier blocks with insulated crimp-type spade lugs. Size lugs properly to assure high electrical integrity, i.e., low resistance connections.

13. Follow manufacturers recommended guidelines for installation.

14. When exiting the primary pathway (such as basketway or cable tray) to the work area, exit via the top of the pathway. Secure the cables to the pathway using an approved cable tie.

C. Cable Routing and Dressing within Telecommunication Rooms

1. Place cables within the overhead cable support and, when routing vertically, fasten the cables onto wall-mounted vertical cable support every 24 inches on-center using cable ties.

2. Only use Velcro type cable ties within the IDF.

3. Neatly bundle (dress cable longitudinally) and support security cables within overhead cable runways.

4. Dress and bind cabling with cable ties every 12" minimum.

5. Provide 4 feet, minimum, sheathed cable slack – length not to exceed permanent link maximum length requirement. Place the slack within the screw cover gutter wireways.

3.2 CABLE SUPPORT

A. Horizontal Support

1. Concrete and Metal construction (Above Ceiling)
a. Provide separate and dedicated cable support system for security cable runs. Anchor cable support system to structural ceiling. Support and tie cables at a maximum of 5-foot intervals.

2. Wood Construction (above ceiling and no ceiling)
   a. Support cable utilizing appropriately sized drive rings or "D" rings.
   b. Fasten rings to structural ceiling.
   c. Install drive rings at approximately 5 foot intervals.
   d. Route cable through drive rings and cable tie at 10 foot intervals, or every other drive.

B. Vertical Support

1. Riser Systems
   a. Route cable through conduit in vertical riser systems.
   b. Terminate conduit at each stacked closet in a lockable junction box. Refer to Section 28 00 00 – Basic Security Requirements for minimum sizing of junction boxes and equipment enclosures.
   c. Fasten entire cable group to the inside of junction box at every other floor or approximately every 24 feet.
   d. Fasten cable in Junction box utilizing cable ties equipped with eyelets designed to accept screws for fastening or approved equivalent method.

2. Vertical cable on floor space not in riser system
   a. Route cable from below suspended ceiling devices to above ceiling when possible.
      1) Provide conduit and firestopping for cable routed in fire rated wall assemblies.
      2) Provide conduit for cable routed from below ceiling devices to above ceiling on concrete tilt up style walls.
   b. Cable routed vertically from devices with no suspended ceiling.
      1) Provide conduit stub from device junction box to 14 feet above finished floor minimum.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working security system installation, as described in these specifications.

B. Section Includes:
   1. Labeling of wire, cable, security devices, enclosures, and raceways.

C. Related Sections:
   1. Consult other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
   2. Section 28 00 00 – Basic Security Requirements: includes general project requirements, submittal formats, warranty, and installation requirements.

1.2 SUBMITTALS

A. Product Data: Submit the following:
   1. Product information for components specified herein.
   2. List of equipment (wire, cable, devices, enclosures, and raceways) and the corresponding text for the label.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Engraved, plastic laminated nameplates, signs, and instruction plates. Engrave stock melamine plastic laminate 1/16 inch minimum thickness for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Use white letters for engraved nameplates and punch for mechanical fasteners.

2.2 LABELS

A. Wire and Cable Labels:
   1. General
      a. Self-laminating adhesive laser labels.
      c. Cable size: 0.16 – 0.32” OD
      d. Color: white with black lettering
   2. Manufacturer:
a. Panduit #R100X125V1T, #R100X150V1T, and R100X225V1T wire marking labels
b. Brady #WML–211-295 and #WML-311-292 wire marking labels
c. Or Equal

B. Device Labels:
   1. Self-laminating, type on tape, adhesive labels. Use Helvetica 12 pt text

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Requirements
   1. Label the security system components. The components include, but are not limited to, the following:
      a. Equipment Enclosures
      b. Conduits
      c. Security Devices
      d. Batteries
      e. Wires and Cables
      f. Equipment Racks
      g. Terminal Blocks
      h. Relays
      i. Patch panels, and the termination positions within the patch panels.
   2. Labels to coincide with device IDs used on the record drawings.
   3. Degrease and clean surfaces to receive nameplates and labels
   4. Install nameplates parallel to equipment lines. Secure nameplates to equipment fronts using machine screws.

B. Equipment Cabinets
   1. Label SEC enclosures associated with the security system with a nameplate.
   2. Mount label on exterior of door, centered horizontally, and positioned one-third of the door height vertically from the top.
   3. Example: Line 1: “SEC-01” (1/2 inch high letters)
      Line 2: “Security Equipment Cabinet” (1/4 inch high letters)

C. Conduits
   1. Write the destination for every conduit entering a junction box, SEC, and CEC enclosure, or wireway using a black permanent ink marker next to the conduit inside the box.
   2. Example: “To SEC-01”

D. Security Devices
   1. Label devices associated with the security system with a permanent machine generated, laminated, label. Use 12 point Helvetica text with a clear background. Use white or black lettering depending upon the color of the device.
2. Label each device in a concealed location with the system point number and address.

E. Batteries
   1. Label power supply batteries with the month and year they were installed.
   2. Example: “April 2012”

F. Wire and Cable
   1. Identify wire and cable clearly with permanent machine-generated labels wrapped about the full circumference within one (1) inch of each connection.
   2. Indicate the cable ID designated on the associated field or shop drawings or run sheet, as applies.
   3. Assign wire or cable designations consistently throughout a given system; i.e., each wire or cable to carry the same labeled designation over its entire run, regardless of intermediate terminations.
   4. Provide labels where wire and cable first enter and exit from conduit, junction or distribution boxes; locate labels within six (6) inches of the point of exit.
   5. Positional labels so they are clearly visible without the need to remove wire management or other obstructions.
   6. Label cables at both ends of a run and within pull and junction boxes using machine generated wrap-around labels.

3.2 CABLE LABEL FORMAT

A. From Panel to Field Device
   1. Line 1: Device Type and Device Number
   2. Line 2: Panel ID – Port Number
   3. Example: CR 001
      
      PANEL 2 – CR5

   4. Standard Device Types
      a. CR = Card Reader
      b. K = Camera
      c. ET = Entry Telephone
      d. R = Relay Output
      e. A = Alarm Point

   5. Standard Port #s
      a. CR = Reader
      b. M = Monitored Input
      c. R = Relay Output

B. From Door Junction Box to Card Reader
   1. Line 1: Device Type and Device Number
   2. Line 2: Panel ID – Port Number
   3. Example: CR 001
C. Miscellaneous Examples:
   1. From Door Junction Box to Door Contact
      a. CR001
      b. DC
   2. From Door Junction Box to Rex Alarm
      a. CR001
      b. REX ALM
   3. From Panel to Rex
      a. CR001
      b. REX PWR
      c. 12 VDC
   4. From Panel to Lock
      a. CR001
      b. LCK PWR
      c. 24 VDC

D. Communications Cable
   1. Line 1: Communication Type and Direction
   2. Line 2: Panel ID
   3. Example: RS-485 TO

   PANEL 2

   4. Typical Communication Types
      a. RS-485
      b. RS-232
      c. RS-422

END OF SECTION
SECTION 28 08 00
SECURITY SYSTEM ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, and transportation required to thoroughly test the completed security system installation as described in these specifications.

B. Base Bid Work
   1. Full testing of a completed security system which includes:
      a. Develop, submit, and obtain Engineer's approval of security system Pre-functional and Functional testing forms.
      b. Complete 100% Pre-functional test of the security system. Submit Pre-functional testing documentation reflecting that all security devices, cabling, locking hardware, power, interfaces to other systems, IT switches, computer/servers and other components required for a completely functional security system are provided per project documents.
      c. Complete 100% Functional test of the security system. Submit Functional testing documentation reflecting that all security equipment, components, interfaces, and programming are functioning correctly per project documents. Upon receiving approval of functional testing documentation, schedule final acceptance testing activities to be witnessed by Engineer and/or Owner.
      d. Demonstrate 100% security system functionality to the Engineer and/or Owner. Document testing activities and submit with final As-Built drawing.

C. Related Sections:
   1. Section 28 00 00 – Basic Security Requirements
   2. Section 28 05 13 – Security System Cabling
   3. Section 28 05 53 – Security System Labeling
   4. Section 28 08 80 – Security System Acceptance Testing
   5. Section 28 13 00 – Access Control and Alarm Monitoring System
   6. Section 28 16 00 – Intrusion Detection System
   7. Section 28 23 00 – Video Surveillance System

1.2 SUMMARY OF SYSTEM COMMISSIONING ACTIVITIES

A. Overview
   1. The purpose of system commissioning is to ensure the security system operates properly when it is needed most. Security systems are very complex from both an equipment and programming standpoint, and thorough testing is necessary to ensure correct operation.
2. Perform testing activities after-hours or on weekends when the system is “quiet” and the building is generally unoccupied. This will minimize the amount of irrelevant activity in the system activity reports that will be used as a record of the pre and final test results.

B. Pre-Functional Test
1. Perform a 100% pre-functional test of system aspects to verify correct operation prior to scheduling the final test. The pre-test will help to make the final test run smoothly when demonstrating the system’s operation to the Owner and Engineer.
2. Document the results of the pre-test using the approved test forms and submit a copy to the Engineer along with the system activity reports.

C. Functional Test
1. Perform a 100% functional test of system aspects to verify correct operation prior to scheduling the final test. The functional test will help to make the final test run smoothly when demonstrating the system’s operation to the Owner and Engineer.
2. Document the results of the pre-test using approved test forms and submit a copy to the Engineer along with the system activity reports prior to final acceptance test.

D. Final Acceptance Test
1. Perform a final test of the system in the presence of the Engineer and/or Owner to demonstrate correct operation of the security system.

1.3 SUBMITTALS
A. Operation and Maintenance Manuals: Submit the following for review and comment at the completion of the project:
   1. Functional Design Manual: Includes a detailed explanation of the operation of the system.
   2. Hardware Manual which includes:
      a. Pictorial parts list and part numbers
      b. Pictorial and schematic electrical drawings of wiring systems, including devices, control panels, instrumentation and annunciators
      c. Telephone numbers for the authorized parts and service distributors
      d. Include service bulletins
   3. Software Manual which includes:
      a. Use of system and applications software
      b. Initialization, start-up, and shut down procedures
      c. Alarm Reports
   4. Operator’s Manual which fully explains procedures and instructions for the operation of the system and includes:
      a. Computers and peripherals
      b. System start up and shut down procedures
      c. Use of system, command, and applications software
      d. Recovery and restart procedures
      e. Graphic alarm presentation
f. Use of report generator and generation of reports

g. Data entry operator commands

h. Alarm messages and reprinting formats

i. System access requirements

5. Maintenance Manual which includes:
   a. Instructions for routine maintenance listed for each component, and a multi-page summary of component's routine maintenance requirements.
   b. Detailed instructions for repair of the security system.
   c. A summary of the software licenses, including license numbers, quantity of clients, summary of the software options provided and database capabilities.
   d. A summary of the TCP/IP address used and which system component they are associated with. Include the gateway address, subnet mask, DNS server, and host name information.

6. Test Results Manual, which includes the document results of tests, required under this Specification, organized by System, Floor, and Door.

7. Record Drawings Manual which includes 11"x17" prints of record drawings as described below.

B. Record Drawings: Submit the following for review and comment at the completion of the project:

1. Drawings to fully represent installed conditions including actual locations of devices, actual cable and terminal block numbering, and correct wire sizing as well as routing. Record changes in the work during the course of construction on blue or black line prints.

2. Include drawings submitted as part of the Shop Drawing package, plus additional information required to accurately document installed conditions.

3. Include the following additional information:
   a. Device addresses & IP address information.
   b. Settings for each camera (lens specs, mm setting, auto shutter setting, and other available camera settings, etc.)

4. Final acceptance will not be made until the Engineer approves the record drawings.

1.4 QUALITY ASSURANCE

A. Provide a project manager to coordinate the security system commissioning work with other trades.
PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 SCHEDULING

A. Coordinate security acceptance testing with the General Contractor, and provide specific information on pre-test and final-testing activities to be entered into the overall project construction schedule.

3.2 TESTING REQUIREMENTS

A. Site Tests

1. Perform a 100% pretest of the system prior to final testing by the Engineer. Provide the Engineer with a minimum of a 5 day notice prior to scheduling testing.

2. At the conclusion of the work on a floor, test the system on that floor to verify proper operation and reporting of devices.

3. Work with the door hardware supplier to resolve electric hardware failures and door alignment/closure problems.

4. At the completion of the work, test the entire system to verify proper operation. At a minimum, include these tests:
   a. Building Perimeter Test: Test doors, cameras, and devices related to securing the perimeter of the building.
   b. MDF/IDF Test: Test devices related to securing the MDF and IDF rooms. Inspect system panels, power supplies, and other related security equipment located in these areas.
   c. Access Control System Test: Test the software for correct programming and setup. Test control and alarm communication through both campus and District security workstations. Verify correct integration with the IDS and Video Surveillance Systems.
   d. CCTV Recording System Test: Test the recording system for correct programming, alarm recording, and event retrieval. Verify correct integration with the ACAMS and IDS system for alarm call-up. Test and verify CCTV system viewable from workstations.
   e. Intrusion Detection System Test: Test the alarm dialer and duress stations for correct programming and operation. Verify correct arming/disarming functions from each keypad and alarm partitioning. Verify integration with ACAMS and Video Surveillance Systems.
   f. CCTV Camera Test: Review cameras for proper coverage, video quality, physical installation, etc.
   g. Other Readers/Door Test: Test remaining card readers, scheduled unlock doors, and exit-only doors not included in the above tests.
   h. Glass Break Test: Test the glass break detectors for correct operation.
   i. Motion Detector Test: Test the motion detectors for correct operation and coverage.
j. Battery and UPS Load Test: Disconnect AC power to security system equipment to verify battery operation functions and system remains fully operational.

B. Test Preparation
1. Provide device identification numbers that differ from or were not included on the original contract drawing set.
2. Provide a complete systems point list.
3. Provide paper and toner for the printer so that an event log can be printed out and attached to the test reports as verification of test sequence and systems response.
4. During testing, provide a minimum of three technicians familiar with the installation to assist with the test. Stage the technicians as follows: one at the host, one at the device being tested, and one runner responsible to furnishing tools, step ladders, etc.
5. Provide radios for use by the Engineer and Owner during testing.
6. Provide pre-programmed access cards for use during testing. Provide one card for each access level.

3.3 TEST PROCEDURES
A. Refer to the test forms for testing procedures for each type of device/system.

3.4 DOCUMENTATION
A. Provide a full-sized blueline drawing containing a detailed wiring diagram (layout of equipment/elevation, complete parts list, and a complete wiring diagram for each ACU & I/O Board) for each SEC. Fold the diagram and place it inside a clear plastic pocket affixed to the inside door of the SEC.

B. Provide a service log on the inside door of each SEC. Include columns for the following information: date of service, description of work performed, service technician(s), service company in the service log. Place the service log inside a separate clear plastic pocket affixed to the inside door of the SEC.

3.5 DEMONSTRATION
A. On completion of the acceptance test, instruct the owner's representatives, at a time convenient to them, in the operation and testing of the system.

B. Utilize the database for the project during training to give the users a project specific example to learn from.

C. Provide a minimum of twelve (12) hours of on-site training by a factory trained representatives. Provide a minimum of three (3) separate training sessions spread out over a twelve (12) month period. Training sessions to be scheduled by the owner at the owner's designated interval within the twelve (12) month period. Maintain a sign in sheet with names and dates of persons trained and forwarded to owner upon completion of training.

D. Provide for two Owner's representatives to attend factory certification training (off-site) for both the following systems:
   1. Access Control System
   2. Video Surveillance System
END OF SECTION
SECTION 28 13 00

ACCESS CONTROL & ALARM MONITORING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working Access Control & Alarm Monitoring system installation, as described in these specifications.

B. Section Includes:
   1. ACAMS client workstations
   2. ACAMS control panels, input/output modules, and card readers
   3. ACAMS power supplies
   4. Alarm initiating devices, including: magnetic switch contacts, and request-to-exit sensors.
   5. Interface to electric door hardware and ADA door operators
   6. Interface to fire/life-safety system
   7. Interface to security subsystems to allow bi-directional communication with one another

C. Products Installed But Not Supplied Under This Section:
   1. Electric feed-through power transfer hinges
   2. Electrified locking hardware cable and termination to transfer hinge and security system

D. Products Furnished and Installed Under another Section:
   1. 120V power
   2. Conduit, junction boxes, and telecom cable trays
   3. ADA door operators and push buttons
   4. Fire/life-safety system interface relays
   5. Electromagnetic door holders
   6. Network connectivity for ACAMS devices via Owner’s local/wide area network

E. Related Sections:
   1. Consult other Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
   2. Section 28 00 00 – Basic Security Requirements: for submittal formats, warranty, general product requirements, and installation requirements.
   3. Section 28 05 13 – Security System Cabling: for cable requirements related to the ACAMS.
6. Section 28 16 00 – Intrusion Detection: for interface requirement to the ACAMS.
7. Section 28 23 00 – Video Surveillance System: for interface requirement with the ACAMS.

1.2 SYSTEM DESCRIPTION

A. Overview

1. The ACAMS is a distributed network of control panels connected to and programmed from an existing host server and client workstations, one located at the District Office and the others at each respective campus.
2. The ACAMS is utilized for electronically controlling access to students, delivery personnel, and staff entrances to the building(s).
3. The ACAMS consists of an existing Software House CCURE 9000 server located at the District Office in Martinez, existing client workstations, control panels, card readers, and alarm initiating devices. The host server communicates with the field panels via the Owner's local/wide area network.
4. Card reader doors must tie into the existing District-wide host server. Develop schedules to automate the opening and closing of the building(s), including unlocking doors, bypassing alarms, and enabling ADA actuation devices.
5. Card readers used in classrooms and/or additional locations as identified by the college must include emergency lockdown capability for shelter in place. The lockdown capability will:
   a. Disable the exterior reader and only allow access via mechanical key only.
   b. Notify Police Services via the access control system and/or the intrusion detection system of emergency lockdown alarm event.
6. The ACAMS also provides secondary alarm monitoring and alarm partition control of the IDS control panels through software integration.

B. Access Control & Alarm Monitoring System

1. Provide ACAMS interface software license for IDS control panels and program to enable bidirectional alarm communication for alarm notification and partition arm/disarm control.
2. Provide ACAMS interface software to VSS network video recorders to enable alarm event recording and automatic call up of associated cameras upon alarm activation (forced door, door held open, etc).
3. Provide ACAMS control panels located in the telecommunication rooms as indicated on project drawings. Coordinate exact location of control panels with local IT department. Panels support up to 16 card readers with locking control outputs and multiple general-purpose input/output modules for automation.
4. Provide input and output modules in a lockable enclosure to support the project specific security system requirements.
5. Provide multi-technology card readers with optical tampers on doors deemed critical to the security of assets subject to a high possibility of theft, sensitive information, or other areas of critical nature and doors with operational requirements such as building entrances, as noted on the project drawings.
6. Provide alarm contacts and request-to-exit motion detectors for card reader controlled doors. Include output from ACAMS to indicate alarm contact status to IDS.
7. Provide alarm contacts for non-card reader controller perimeter doors as indicated on project drawings.
8. Utilize IDS integration to monitor motion detector and duress alarms through the ACAMS workstation.
9. Provide interface to ADA automatic/power assist door operator and corresponding actuator push plates or optical motion detection actuators.
   a. When door locked, exterior push plate/optical sensor is disabled
   b. When door unlocked, even momentarily, push plate/optical sensor is enable.
   c. Interior push plate/optical sensor unlocks door and triggers automatic door operator at all times.
10. Provide 12/24VDC ACAMS device and lock power supplies as indicated on project drawings with enclosure tamper switches.
11. Provide battery backup of system components and power supplies.

C. Fire/Life-Safety System Interface
1. Coordinate with Fire/Life-Safety system contractor to automatically drop power from stairwell, elevator lobby, and other doors within the path of egress upon alarm activation of the Fire/Life-Safety system.
2. Coordinate with Fire/Life-Safety system contractor for scheduled release of electromagnetic door holders on designated card reader doors as indicated on project drawings. Provide ACAMS output modules as necessary to interface with Fire/Life-Safety system.

D. Tamper Monitoring
1. Provide additional monitor input points for monitoring the following:
   a. Tamper switches located within each security equipment enclosure and wireway (use unsupervised inputs for this purpose).
   b. Supervision of power supplies and batteries (use unsupervised inputs for this purpose).
   c. Tamper switches located within each door junction box.

1.3 SUBMITTALS

A. Contractor Qualifications: Submit certification letters for the manufacturer of the ACAMS.
B. Product Data: Submit product information for components specified herein.
C. Shop Drawings:
   1. Device placement on floor plans
   2. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices between the following:
      a. ACAMS control panel
      b. ACAMS card reader and input/output modules
      c. ACAMS power supplies
      d. Card Readers
      e. Alarm contacts and request-to-exit sensors
f. Interface to electrified door hardware

g. Interface to ADA auto operators and actuators

h. Interface to fire/life-safety system

i. Hardwired interfaces to IDS

j. Cable conductors (identify conductors on the point-to-point diagrams with the same tag as the installed conductor)

3. Schedules: Provide schedules for ACAMS control panels that show each point ID with a description of the connected devices.

4. Block Diagram/Riser Diagram: Show the ACAMS components, conduit, wire types, and sizes between them, including cabling interties between termination hardware.

5. Custom mounting details

1.4 EXTRA MATERIALS

A. Provide 10% spare parts of total installed the following: (Round up to the next complete device)

1. Card Readers

2. Fuses (Place five (5) of each type of fuse inside each SEC and power supply housing).

3. Relays

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Access Control & Alarm Monitoring System

1. Software House CCURE 9000 to match campus standards

2.2 ACAMS CONTROLLERS

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 include:
   a. Central control for attached devices and addressable modules
   b. Makes decisions for access
   c. Responds to monitor activity
   d. Receives input to control its 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 ULTRA 64MB control panel
      a. Accessories
         1) Software House # I8 input module
         2) Software House # R8 output module
         3) Software House # RM-4E reader interface module
         4) Allegion PIM400-485; Panel Interface Module

2.3 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 type 1 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 # 36246-1PP with back panel and lock kit
      b. Hoffman #A36N24M with #A36N24MPP back panel and #A612AR lock kit
      c. Or Equal

C. Security Junction Boxes
   1. Type: NEMA type 1 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 # 12126-1PP with back panel and lock kit
b. Hoffman # A12N126 with #A12N12PP back panel and #A612AR lock kit
c. Or Equal

D. Slotted Wiring Duct
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

2.4 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” x 4” x 48” minimum
3. Finish: ANSI 61 gray polyester powder paint finish inside and out
4. Manufacturer:
   a. Copper B-Line # 4448-G-NK lay-in painted wireway without knockouts
   b. Hoffman # F44T148GVP lay-in painted wireway without knockouts
   c. Or Equal
5. Accessories:
   a. Cooper B-Line # 44-E-NK closure plate without knockouts
   b. Hoffman # A44GCNPNK closure plate without knockouts
   c. Or Equal

2.5 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

2.6 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 conform 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 (MyD, ICODE, Tag-it), ISO 14443A CSN (MIFARE, DESFire), ISO 14443B CSN, and US Government PIV

B. Manufacturer
1. HID # multiCLASS series
   a. Wall mount: HID # RP40 multi-technology card reader
   b. Mullion style: HID # RP15 multi-technology card reader

2.7 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

2.8 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 1,000 MHz at 50 v/m

B. Manufacturer
   1. Bosch #DS160 with TP160 trim plate
   2. Honeywell #IS320WH with IS310WHTP trim plate
   3. Or Equal

2.9 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

2.10 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

3.1 INSTALLATION

A. ACAMS Control Panels
   1. Place power supply and associated hardware in same location.
   2. Install supervisory and end-of-line (EOL) resistors as required. Refer to Section 28 00 00 – Basic Security Requirements for EOL supervision requirements.
   3. Connect power supply tamper switches to ACAMS for SEC hub monitoring.

B. Four-State End-of-Line (EOL) Supervision
   1. Provide designated resistors at device end of line per manufacturer's EOL recommendation to provide four-state supervision of security device and cabling.
   2. Provide EOL supervision for alarm contacts, local alarm sounders, motion detectors, help/dress buttons, and other designated security devices connected to the ACAMS and IDS.
   3. Provide the following states of supervision:
      a. Contact closed = Secure
      b. Contact open = Alarm
      c. Short circuit = Line fault
      d. Open circuit = Line fault

C. Card Readers
   1. Wire the card reader's multi-color LED to indicate the following status of the door.
      a. Red status indicates the door is secure (locked).
      b. Green status indicates the door is unsecured (unlocked).
      c. Yellow status indicates the card reader is not functioning (off-line/trouble), is processing a read request, or has denied access.
   2. Utilize configuration card to enable optical tamper.
   3. Wire the card reader's optical tamper to spare input on the ACAMS reader module and jumper ground wire from door contact to provide a Normally Closed circuit.
   4. The card reader to produce an audible beep tone to indicate to the user:
      a. The card was read and/or access was denied.
      b. Door is being held open and needs to be closed.

D. Door Hardware
1. Route power to electrically controlled locks on life-safety doors through fire alarm output to automatically unlock the door upon activation of Fire/Life-Safety system. Connect fire alarm output to the disconnect relay on the associated 24VDC lock power supply.

2. Setup and conduct a door hardware coordination meeting.

3. Coordinate the installation and termination of the security cable with the installation of the electric door hardware and transfer hinge.

4. Provide cable and terminate wires to delayed egress devices for monitoring activation of delayed egress by the ACAMS system.

E. Door Contacts
   1. Install on protected (secured) side of door.
   2. Install 6" from leading edge at top of door.

F. Request-To Exit Motion Detectors
   1. Mount motion detector on the secured (protected) side of door.
   2. Install motion detector so that detection pattern is not obstructed by Exit Signs, light fixtures and other objects that would interfere with proper operation.
   3. Adjust relay hold time and pattern to properly detect valid exit and allow shunting of door contact.
   4. Adjust detection sensitivity to pulse.
   5. Mask detector lens to provide a confined detection area limited to the door handle or pushbar.
   6. Run wire inside structural tube steel frame into back of conduit for cage locations.

3.2 PROGRAMMING

A. Prior to the completion of construction, schedule and hold a meeting with the Owner to determine the programming criteria. Discuss the following:
   1. Door and device names
   2. Access card levels and door groupings
   3. Alarm priority levels
   4. Alarm integration with IDS including arming and disarming protocol through the ACAMS card readers (for example valid card disarms alarm partition while presenting card two times arms alarm partition)
   5. Schedules and time codes
   6. Holidays and holiday types (priorities)
   7. Action/responses from individual input points
   8. Standard and custom (expanded) reports
   9. Defining alarm messages and standard response messages applicable to site
   10. Routing of alarm points to selected pagers
   11. Routing of alarm points to operator's workstations, printers, and history files
   12. Coordinate implementation of graphics with Owner. Develop sample graphic complete with icons and text. Alarms to appear on building floor plans depicting the nature and location of alarms. Review and revise graphic layout as required by Owner.
13. System database backup to external hard-drives

B. Document the results of the meeting and perform necessary programming to achieve the Owner’s requests.

C. System Operation, Alarm and Reporting Function: Program door control panel tamper switches to immediately reported as a separate “tamper” point to the system resulting in an alarm condition displayed in both text and graphic form on the applicable workstation(s) and an alarm message transmitted to the appropriate pager(s).

D. Receive CAD drawing files of floor plans and perform the following relative to system graphics:
   1. Delete non-applicable drawing layers and details to arrive at simple floor plans of the building as built.
   2. Convert drawings to a graphic file format compatible with the Owner’s access control and alarm monitoring system.
   3. Load drawing files into the system.
   4. Apply new and predefined icons and other points on each graphic to indicate point and control status.
   5. Link graphic images to reader, monitor and control points.

E. Program routing of monitor and control points. Route activations and restore messages to one or more of the following locations as directed by the Owner’s Representative:
   1. One or more system workstations;
   2. One or more system printers;
   3. One or more alphanumeric pagers;
   4. History files in addition to the above;
   5. History files only.

F. Program the system such that reliance on a remote host for routine building operations, such as scheduled door commands and conditional events, are minimized to the greatest extent possible and decisions are made at the local building controller.

G. Program the system in a manner that minimizes the amount of time required for the users to make updates and maintain the system on a daily basis especially updates that impact card holder record updates. Nested programs, such as reader groupings used in access codes shall be used to the greatest extent possible such that single actions are required to update an entire card data population. If there is a question regarding the appropriate approach to programming, given the flexibility of most systems, contact the Engineer prior to any initial programming.

H. Complete other programming as required for system operation.

I. Program and setup the system such that no additional programming other than entering new access cards is required. Include setup of available features of the software.

J. Use the point names provided on the system point schedule.

K. Perform 2 full system back-ups at completion of initial programming and deliver one copy to owner with letter of Transmittal explaining information included in back-up and brief
description of recovery procedures. Label the second CD-ROM and store onsite. Perform back-ups on a regular basis through the remainder of the project.

L. Customize menus with the assistance of the factory to "gray-out" features not used on project (such as elevator control).

M. Perform field software changes after the initial programming session to "fine tune" operating parameters and sequence of operations based on revised operating requirements.

3.3 TESTING

A. Commission ACAMS in accordance with Section 28 08 80.

END OF SECTION
SECTION 28 16 00

INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction, and special or occasional services required to make a complete working intrusion detection system installation as described in these specifications.

B. Section includes:
   1. Intrusion Detection System, including digital communicator, keypad, and alarm devices.
   2. Door contacts, glass break detectors, motion sensors
   3. Duress alarm stations
   4. Interfaces and connections between intrusion detection subsystems to allow communication with one another

C. Products furnished and installed under another section:
   1. 120V power
   2. Network connectivity for IDS Panel via Owner’s local/wide area network
   3. Phone line

D. Related sections:
   1. Section 28 00 00 – Basic Security Requirements: for submittal format, warranty, general product requirements, and installation requirements
   2. Section 28 13 00 – ACAMS: for interface requirement to the intrusion detection system
   3. Section 28 05 13 – Security System Cabling: for cable requirements related to the IDS
   4. Section 28 05 53 – Security System Labeling: for device labeling requirements
   5. Section 28 08 00 – Security System Acceptance Testing: for testing requirements

1.2 SYSTEM DESCRIPTION

A. Overview
   1. The IDS is comprised of multiple areas that can be armed and disarmed independently of each other through IDS keypads.
   2. The IDS is utilized for after hours monitoring of the building(s), interior partitions and alarm zones. The IDS will also be utilized for 24-hour monitoring of specific areas which include but are not limited to duress buttons, glass breaks, etc.
   3. Activation of the IDS dials a remote, third party central station to first contact Police Services on campus during campus hours or dispatch the local San Pablo Police Department after hours.
   4. The IDS integrate with the ACAMS through software to send alarm information for secondary monitoring with the ACAMS and hardwired input points for remote monitoring of ACAMS door alarm contact status.
B. Intrusion Detection System

1. Provide an IDS control panel with integrated UL listed digital communicator shown on the project drawings. Panels support up to 8 areas and 64 zones by use of addressable input/output point modules.

2. Provide LCD command keypads as indicated on project drawings. Keypads allow for system arming and disarming by authorized users.

3. Provide wireless back up alarm communicator.

4. Provide under counter duress buttons as indicated on project drawings. Program duress alarm inputs as 24 hours zones.

5. Provide motion and glass break sensors as indicated on project drawings.

6. Provide 12VDC auxiliary power supply to support the field devices indicated on project drawings.

7. Provide battery backup of IDS components and power supplies for a minimum of 24 hours in the event of a power failure or emergency.

C. Interface with ACAMS

1. Connect ACAMS alarm outputs to the IDS control panel. Provide expansion modules as necessary to support the security devices shown on the project drawings.

2. Integrate IDS with ACAMS for alarm monitoring and alarm partition arming/disarming through ACAMS workstation(s).

D. Tamper Monitoring

1. Provide additional monitor input points for monitoring the following:
   a. Tamper switches located within each security equipment enclosure and wireway (use unsupervised inputs for this purpose).
   b. Supervision of power supplies and batteries (use unsupervised inputs for this purpose).

1.3 SUBMITTALS

A. Product Data: Submit product information for the intrusion detection systems, including:

1. IDS control panel
2. Keypads
3. Cellular backup communicator
4. Motion sensors
5. Glass break sensors
6. Alarm contacts
7. Local audible alarms
8. Power supplies
9. Calculations for backup batteries

B. Shop Drawings: Submit shop drawings containing the following:

1. Device placement on floor plans
2. Point-to-Point Wiring Diagrams: Include wiring, points of connect, and interconnecting devices between the following:
   a. IDS control panel
   b. IDS expansion modules and relays
   c. Keypads
   d. Motion sensors
   e. Glass break sensors
   f. Alarm contacts
   g. Local audible alarms
   h. Power supplies
   i. Cable conductors (identify conductors on the point-to-point diagrams with the same tag as the installed conductor)

3. Schedules: Provide schedules for the IDS control panel that show each alarm zone, applicable area or partition, and a description of the connected device.

4. Custom mounting details

1.4 EXTRA MATERIALS

A. Provide 10%, of the total installed, spare parts for the following: (Round up to the next complete device)
   1. Motion sensors
   2. Glass break sensors
   3. Duress buttons
   4. Alarm contacts

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Intrusion Detection System
   1. DSC to match campus standard

2.2 IDS CONTROL PANELS

A. General
   1. Integrated UL listed digital communicator with phone line monitor (loop or ground start).
   2. Supports up to 64 alarm zones and 8 programmable areas or partitions.
   3. Capable of utilizing multiple telephone numbers, primary and duplicate paths with main and alternate destinations.
   4. Capable of utilizing a dual phone line switcher to monitor 2 phone lines.
   5. Capable of sending daily automatic test and status reports.
   7. Supports RS-232 connectivity to third party devices for automation.

B. Manufacturer
1. DSC PowerSeries #PC1864 8-64 zone control panel
   a. Accessories
      1) DSC #PC5200 Power Supply Module
      2) DSC #PC5204 Power Supply Module
   b. Expansion modules
      1) DSC # PC5100 Addressable Xone Expander
      2) DSC # PC5108 8-Hardwire Xone Expander
      3) DSC # PC 5208 Programmable Output Module
      4) DSC # IT-100 Integration Module
      5) Lantronix # UDS1100 w/ #500-163-R cable adapter
      6) DSC #TL250GS Internet Alarm Communicator
   c. Wireless back-up communication device
      1) DSC #GS3060; Universal Wireless Alarm Communicator

2.3 IDS KEYPADS
A. General
   1. 32-character display
   2. Keys light on entry or key press
   3. Back lighted multi-key touch pad
   4. User controlled brightness and loudness

B. Provide the ability to display for each detection point:
   1. Alarm
   2. Trouble
   3. Supervisory
   4. Faulted
   5. Custom text

C. System wide displays include:
   1. Local system test
   2. Sensor reset
   3. Event log

D. Manufacturer
   1. DSC #PK5500 64-Zone LCD Full-Message Keypad

2.4 MOTION SENSORS
A. General
1. Type: Passive infrared (PIR) detector with Fresnel type lens
2. Operating Voltage: 10-14VDC
3. Range: 35' x 35' minimum
4. Integrated tamper switch

B. Manufacturer
   1. Wall mount
      a. Bosch # ISM-BLP1 blue line PIR detector
      b. Or Equal
   2. Ceiling Mount
      a. Bosch # DS938Z panoramic PIR detector
      b. Or Equal

2.5 GLASS BREAK SENSORS

A. General
   1. Type: Digital, utilizing DSP technology
   2. Operating Voltage: 6-18 VDC
   3. Range: 25’ maximum, omnidirectional
   4. Integrated tamper switch

B. Manufacturer:
   1. Honeywell # FG-1628T glass break sensor
   2. Or Equal

2.6 MAGNETIC CONTACT SWITCHES

A. Wood, Steel, and Hallow Metal Doors
   1. Mounting: Recessed
   2. Contacts: Single Pole, Single Throw
   3. Gap Distance: 1.0" maximum
   4. Manufacturer:
      a. GE Security # 1078 1" alarm contact switch
      b. Or Equal

2.7 IDS POWER SUPPLIES

A. General
   1. Provides a 120VAC to 12/24VDC output, fully supervised power supply to power IDS field devices.
   2. Utilizes 16 PTC 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 6 amp supply current.
B. Manufacturer
   1. Altronix # AL600ULXPD16CB multi-output power supply/charger
   2. Or Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
   1. Follow manufacturers recommended guidelines for installation.

B. Components
   1. IDS Control Panel
      a. Utilize dedicated power supplies to power control panel and associated expansion boards. Do not use plug-in transformers.
      b. Place power supply and associated hardware in same location.
      c. Install supervisory and end-of-line resistors on alarm initiating devices.
      d. Coordinate installation of phone jack and network connection in IDS control panel enclosure for communications to the contracted central station and integration with the ACAMS.
   2. Keypads
      a. Mount keypads as indicated on project drawings.
   3. Motion Sensors
      a. Mount motion detectors as indicated on project drawings. Verify current location to maximize coverage prior to installation.
      b. Install motion detector so that detection pattern is not obstructed by exit signs, light fixtures, and other objects that would interfere with proper operation.
   4. Glass Break Sensors
      a. Mount glass break detectors as indicated on drawing. Verify correct location to maximize coverage prior to installation.
   5. Door Position Contacts, where not installed for ACAMS
      a. Program input on IDS control panel to receive alarm output from ACAMS indicating card reader door forced or door held-open alarm.
      b. Install on protected (secured) side of door.
      c. Install 6" from leading edge at top of door.

3.2 PROGRAMMING

A. Prior to the completion of construction, schedule a meeting with the Owner to determine the following programming criteria:
   1. Zone or alarm point descriptions
   2. User authority levels to arm/disarm areas or alarm partitions
   3. Auto arm/disarm schedules
   4. Arm/disarm requirements through the ACAMS using specific credentials.
5. Interface requirement with ACAMS
6. Central station response from individual alarm points
7. Central station password and call list information

B. Document the results of the meeting and perform necessary programming to achieve the Owner’s requests. Program and setup the system such that no additional programming other than entering new access codes is required.

3.3 TESTING
A. Commission the Intrusion Detection System in accordance with Section 28 08 80.

END OF SECTION
SECTION 28 23 00

VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. General: Provide engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction, and special or occasional services as required to make a complete working video surveillance system installation, as described in this specification.

B. Section Includes:
   1. VSS Monitoring and Recording System
   2. VSS Fixed, Multi-sensor, and PTZ IP cameras, lens, mounts, and housing
   3. VSS Power supplies
   4. Integration with ACAMS
   5. Interfaces and connections between VSS subsystems to allow communication with one another

C. Products Supplied But Not Installed Under This Section:
   1. None

D. Products Installed But Not Supplied Under This Section:
   1. None

E. Products Specified But Not Installed Under This Section:
   1. None

F. Products Furnished and Installed Under another Section:
   1. 120V power
   2. Ethernet cable back to telecommunication for IP cameras
   3. PoE switches in the telecommunications rooms for VSS connectivity via LAN/WAN

G. Related Sections:
   1. Consult other Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
   2. Section 280000 Basic Security System Requirements: includes general project requirements, submittal formats, installation, and warranty requirements.
   3. Section 281300 Access Control & Alarm Monitoring System: includes product information for video integration with the ACAMS.
   4. Section 280513 Security System Cabling: includes product information for wire and cable needed to support the video surveillance system.
   5. Section 280553 Security System Labeling: includes label types and formats for security devices.
6. Section 28 08 80 Security Acceptance Testing: includes the integrating testing/commissioning requirements for the video surveillance system.

1.2 DEFINITIONS

A. The Definitions of Division 1 apply to the 28 23 00 sections.

B. In addition to those Definitions of Division 1, the following list of terms as used in this specification defined as follows:

1. “IP”: Internet Protocol
2. “NVR”: Network Video Recorder
3. “VMS”: Video Management System
4. “PTZ”: Pan-Tilt-Zoom
5. “NAS”: Network Attached Storage
6. “PoE”: Power-over-Ethernet
7. “VSS”: Video Surveillance System

1.3 SYSTEM DESCRIPTION

A. Overview

1. The VSS is a network of IP cameras connected to and managed through a video management and recording server software and viewed on client workstations. The recording servers are managed and provided by District / Campus IT on centrally located servers.

2. The VSS consists of interior and exterior fixed and PTZ IP cameras, networked video recorders, management software, and dedicated client video monitoring workstations.

3. Cameras will integrate with the ACAMS through software and TCP/IP communication for alarm events which initiate video recording and tag video with specific alarms.

B. VSS Camera System - Base Bid

1. Provide VSS software and licenses capable of video motion detection and integration capabilities with the ACAMS software for alarm interface.

2. Provide the appropriate number of video licenses for IP cameras connected to the VSS video management system.

3. Coordinate installation of VSS camera licenses on centrally located network video server(s) hardware provided by the Owner. Provide District / Campus IT the bandwidth and storage requirements for cameras included under the project scope to ensure appropriate resources are available.

4. Coordinate network connection between IP cameras and existing security workstation at the Police Services Office with the District’s IT department prior to installation.

5. Coordinate one static IP network connection for each camera.

6. Provide IP fixed VSS cameras as indicated on the floor plans.

7. Provide IP multi-sensor VSS cameras as indicated on the floor plans.

8. Provide IP PTZ VSS site camera as indicated on the floor plans.

9. Provide day/night cameras in outdoor locations with low light levels. Coordinate field of view with exterior light sources to prevent poor image quality.
10. Provide VSS camera power supplies (if needed) for PTZ and exterior camera enclosures.

11. Provide software interface to the ACAMS for alarm call up of cameras and PTZ specific presets on predefined alarm events.

C. Tamper Monitoring
   1. Provide additional monitor input points for monitoring the following:
      a. Tamper switches located within each security equipment enclosure and wire way
      b. Supervision of power supplies and batteries

1.4 SUBMITTALS

A. Contractor Qualifications: Submit certifications for the manufacturers of the video surveillance equipment.

B. Product Data: Submit product information for components specified herein.

C. Shop Drawings:
   1. Device placement on floor plans.
   2. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices between the following:
      a. Video surveillance system, monitors, and recording equipment
      b. Devices connected to the system
      c. Miscellaneous control relays
      d. Conductors (identify conductors on the point-to-point diagrams with the same tag as the installed conductor)
   3. Block Diagram/Riser Diagram: Show the video surveillance system components, conduit, wire types, and sizes between them, including cabling interties between termination hardware.
   4. User interface graphics with icons and control buttons displayed.
   5. Custom mounting details

1.5 EXTRA MATERIALS

A. Provide 10% spare parts of total installed the following: (Round up to the next complete device)
   1. Fuses (Place five (5) of each type of fuse inside each power supply).

1.6 WARRANTY

A. Camera Systems
   1. Provide a manufacturer’s warranty covering repair or replacement of defective parts for a period of one year from the date of shipment from the factory
   2. Cameras and support devices
      a. Provide a manufacturer’s warranty covering repair or replacement of defective parts for a period of one year from the date of shipment from the factory.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Video Surveillance System
   1. Network Video Recorder Software
      a. Salient Systems
   2. IP Cameras
      a. Sony
      b. Axis Communications
      c. Arecont Vision
      d. Or Equal
   3. Power Supplies
      a. Altronix
      b. Pelco
      c. Or Equal

2.2 CAMERA SYSTEMS

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 line. No auxiliary sync cable required.
   6. Resolution: 640x480 minimum resolution (EIA RS-170), 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
   9. Video transmission through IP or analog signals through IP encoder

B. Fixed IP Interior Dome Cameras
   1. Complete prepackaged 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, varifocal lens of 2.5-6mm
      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) Power - Mini DC

h. Dome housing

2. Manufacturer:
   a. Axis #P33 Series 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 #P33 Series 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
      4) 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

E. Multi-sensor camera

1. Complete prepackaged unit containing:
   a. Minimum resolution: (4) 1920 x1080
   b. Video Compression format: H.264
   c. Power over Ethernet (IEEE 802.3af, Class 2)
   d. Frame Rate: 12.5 fps at H.264
   e. Sensor: Four 1/2.8" progressive scan RGB CMOS sensors
   f. Vandal Resistant Dome
2. Manufacturer, or equal:
   a. Axis P3707-PE
3. Accessories, or equal:
   a. AXIS T91D61 Wall Mount including weather shield
2.3 VIDEO MANAGEMENT SOFTWARE

A. 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 (to match existing standard)
      b. Salient Systems LPR Tracker

2.4 POWER SUPPLIES/BATTERY CHARGERS

A. VSS 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

2.5 VSS 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
PART 3 - EXECUTION

3.1 INSTALLATION

A. VSS 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. VSS 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 owner provided 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.

3.2 PROGRAMMING

A. Coordinate a meeting with Owner's IT representative to determine IP addresses and LAN/WAN utilization of IP cameras and NVRs.

B. Prior to the completion of construction schedule a meeting with the Owner and the Engineer to determine the programming criteria. Discuss the following:
   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.

3.3 TESTING

A. Commission the video surveillance system in accordance with Section 28 08 80.

END OF SECTION
SECTION 28 31 00

FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY DESCRIPTION

A. Provide NFPA 72, 2016 edition, code compliant manual addressable fire detection system and audible/visual alarm systems.

B. Contractor is advised that the drawings are diagrammatic in nature and are not intended to show all details. Contractor shall provide final design and provide all miscellaneous parts and labor required to install a complete workable system.

C. Related Sections include the following:
   1. 26 05 33 Raceway and Boxes
   2. 28 31 23 Conductors and Cables for Electronic Safety
   3. 26 05 53 Identification

1.2 DEFINITIONS

A. Wherever mentioned in this specification or on the drawings the equipment, devices, and functions shall be as defined in Section 01 42 00 References and supplemented as follows:

1. Emergency: An unsafe or intolerable condition requiring immediate correction.

2. FACP: A Fire Alarm Control Panel, which processes alarm information and controls outputs.

3. Alarm Signal: A signal that indicates a state of emergency requiring immediate notification of the fire department and of the building occupants. These are signals such as the operation of a manual pull station, the activation of a water flow switch in a sprinkler system, the receipt of an alarm signal from a smoke detector that has gone through alarm verification, the receipt of an alarm signal from an elevator smoke detector or a computer room smoke detection panel, the operation of a heat detector, or the operation of a pressure switch in a fire suppression system caused by the flow of fire extinguishing agent (e.g. kitchen fire extinguishing system, CO2, etc.).

4. Supervisory Signal: A signal that indicates the impairment of a fire protection system, which may prevent its normal use. These are signals from switches, such as a tamper switch; a low air pressure switch; a high air pressure switch; a generator phase reversal switch; a generator power failure switch; a generator running switch; a fire pump phase reversal switch; a fire pump loss of power switch; a fire pump running switch; or a duct smoke detector.

5. Trouble Signal: A signal that indicates that a fault, such as an open circuit or ground, has occurred in the fire alarm system or in a separate sub-system, whose control panel is monitored by the fire alarm system.

6. Multiplex System: A system in which multiple signals are transmitted via the same conduction path to a remote fire alarm control unit and fire alarm control panel, decoded and separated so that each signal will initiate the specified response.
7. Notification Appliance Circuit: A circuit to which notification appliances are connected to visually and audibly indicate an alarm signal.

8. Interface Device: An addressable device which interconnects hard wired systems or devices to a multiplex system.

9. Fire Alarm Power Boosters: Control panels that supply power to the notification appliances devices; and reports to and receives signals from the fire alarm control panel.

10. Master Fire Alarm Control Panel (MFACP): A master control panel having the features of a fire alarm control unit and to which all fire alarm control units are interconnected and report to. The panel has central processing, memory, input and output terminals, video display units (VDUs) and printers.

11. Class A Wiring: A circuit that is monitored for integrity such that a single break, a single wire-to-wire short, or a single loss of carrier condition will be indicated by a trouble signal on the FACP no matter where the break, short or loss of carrier condition occurs and will allow all functions of the affected circuit to remain operational. In accordance with NFPA 72, this would be Style 7 wiring for signaling line circuits.

12. Class B Wiring: A circuit that is monitored for integrity such that a single break, a single wire-to-wire short, or a single loss of carrier condition will be indicated by a trouble signal on the FACP no matter where the break, short or loss of carrier condition occurs, but which would prohibit devices beyond the fault, short or carrier loss from remaining operational. In accordance with NFPA 72, this would be Style 4 wiring for signaling line circuits, Style B for initiating device circuits, and Style Y for notification appliance circuits.

13. Signaling Line Circuit: A circuit to which any combination of circuit interfaces, control units, or transmitters are connected and over which multiple system input signals or output signals, or both, are carried.


15. Tamper Switch: A valve monitor switch as indicated in NFPA 72.

16. Initiating Device: A system component that originates transmission of a change of state condition, which initiates an appropriate response via the fire alarm system.

17. Terminal Cabinet: A steel cabinet with locking, hinge-mounted door in which terminal strips are securely mounted. Minimum size is 200 mm x 200 mm (12 inch x 12 inch).

18. VAC: Volts Alternating Current.

1.3 PERFORMANCE REQUIREMENTS

A. This specification establishes the requirements for the design and installation of a complete fire detection and alerting system as described in this Section and the Drawings.

B. Scope of Work

1. The scope of work includes, but is not limited to, provision of the following:
   a. Detailed design and preparation of shop drawings, to meet the design as indicated in the Drawings and these Specifications.
   b. Installation of the complete fire detection and alerting system.
   c. System software, database management utilities, firmware, and programming as required to provide a complete functioning interactive system.
d. All necessary conduit and wiring associated with the fire detection and alerting system.

e. Smoke detectors, heat detectors, duct detectors, test switches, and manual pull stations.

f. Horns/speakers, strobes and remote lamps.

g. Permanent signs, labels, and operational instructions.

h. Systems and Equipment Startup and Testing

i. Commissioning

j. Training.

k. Record drawings.

C. Codes and Standards

1. Applicable Publications: Provide a system conforming to the requirements of the latest edition of the following publications including all amendments to these publications.

   a. American Society for Testing and Materials (ASTM)

   b. American Society of Mechanical Engineers (ANSI/ASME):


   d. National Fire Protection Association (NFPA):
      1) 70 National Electric Code (NEC)
      2) 72 National Fire Alarm Code
      3) 13 Standard for the Installation of Sprinkler Systems
      4) 20 Standard for the Installation of Centrifugal Fire Pumps
      5) 101 Life Safety Code
      6) 90A Standard for the Installation of Air Conditioning and Ventilating Systems
      7) 17 Dry Chemical Extinguishing System

2. State and Local Codes: Perform all work in accordance with the requirements of the latest issue of the following codes and standards, unless specifically directed otherwise in this specification in order to allow designs in excess of the code requirements. Applicable portions of current editions as adopted by the California State Fire Marshal of the publications listed below form a part of this Specification:

   a. California Code of Regulations, Title 24, Parts 2,3,4,9, and 12
   b. California Code of Regulations, Title 19
   c. Americans with Disabilities Act (ADA)
   d. California Building Code, Part 2
   e. California Electric Code, Part 3
f. California Mechanical Code, Part 4

g. California Fire Code, Part 9

3. EIA, IEEE, NEMA and ANSI standards pertaining to fire detection, alarm and communication systems.

D. Nameplates and Labeling

1. All fire alarm components shall be labeled. Identification tags shall be red, laminated plastic with engraved white lettering. Labels shall be mounted on panels with screws. Fire Alarm Account numbers will be issued by the District’s Representative.

2. Each FACP shall have a label placed on the front of the control panel indicating with 1/4 inch lettering stating: “ACCT. ###”. The numbers shall indicate the account number.

3. Each fire alarm terminal box installed in or on a wall shall have a red laminated plastic identification label with 1/4 inch lettering stating “FIRE ALARM TERMINAL” on the front cover.

4. Where terminal boxes are concealed in the ceiling, the box shall have a red laminated plastic identification label with 1/4 inch lettering stating “FIRE ALARM TERMINAL” attached to the front face of the box. A red laminated plastic identification label with 1/4 inch lettering stating “FIRE ALARM TERMINAL” shall be permanently attached to the ceiling T-bar grid at the access point or next to the access door nearest the terminal box.

5. Heat, smoke, products of combustion and addressable modules shall have red laminated plastic identification label with 1/4 inch lettering stating “[module, point, zone] M:## s:### ZN ##” with the numbers indicating the device. Label device and/or module in an unobtrusive location where not visible when the device/module is installed.

1.4 SYSTEM OPERATION – GENERAL REQUIREMENT

A. Fire alarm functions: Activation of a pull station, sprinkler water flow or activation of an automatic sensing device for fire, temperature, flame, or smoke shall result in the following:

1. An audible and visual evacuation alarm signal will continuously sound a temporal 3-pulse signal until the system is silenced, reset or voice override is utilized.

B. Supervisory functions

1. Supervise the 120 VAC circuits supplying the FACP.

2. Supervise the alarm initiating circuits, building signaling circuits, and auxiliary control circuits, except the door circuits, against grounds, opens, and shorts.

3. Any equipment trouble or malfunction or activation of a sprinkler system supervisory switch shall transmit a trouble signal.

4. Upon application or reappllication of 120 VAC power, the fire alarm system shall automatically, without any operator intervention, initialize all circuitry and shall be in a normal operating condition. Systems which require operator intervention to reset manual controls following a 120 VAC restoration are not acceptable.

1.5 SYSTEM SEQUENCE OF OPERATION - DETAILED DESCRIPTION

A. Signal Activation Sequence
1. Standard Responses Upon Activation: For all situations in Alarm Signal Activation Sequence paragraph standard response upon activation shall result in the following:
   a. The FACP will go into alarm mode and the module, point, zone/deception in alarm will be annunciatered at LCD displays.
   b. The appropriate zone will operate and transmit the alarm signal via two dedicated telephone lines to the UC Davis Dispatch Center.
   c. An audible and visual evacuation alarm signal throughout the building will continuously sound a temporal 3-pulse signal until the system is silenced or reset.

2. Pull station activation shall result in the following:
   a. All standard responses upon activation

3. Sprinkler water flow activation shall result in the following:
   a. All standard responses upon activation
   b. Activate exterior water flow bell.
   c. Waterflow bell shuts off when water stops flowing.

4. Area Smoke Detectors:
   a. Area smoke detector, heat detector, or flame detector activation anywhere in the facility shall cause the following to happen:
      (1) Standard responses upon activation.

1.6 SUBMITTALS

A. Conform to Section 01 33 23 Shop Drawings, Product Data and Samples and to the requirements of Section 01 78 39 Project Record Documents. All plans, calculations, and product data (including California State Fire Marshal approval sheets) shall be submitted as required by NFPA 72, current edition.

B. Procedure
   1. Prepare and submit copies of shop drawings, catalog cut sheets, California State Fire Marshal (CSFM) listing sheets, and additional information required in this section.
   2. Contractor shall not start any construction on the fire alarm system prior to approval of related submittals.

C. Manufacturer’s Product Data-Submit the following:
   1. Equipment schedule showing exact types, current CSFM listing, and quantity of all fire alarm devices.
   2. Technical data showing exact types of all fire alarm devices. Specific components on catalog cut sheets must be highlighted or otherwise identified. All equipment drawing alarm or supervisory current shall have documentation of the current draw clearly marked and highlighted in the submittal information.
   3. Technical information showing physical dimensions, weight, finish and mounting requirements.

D. Shop Drawings
   1. Submit shop drawings as follows:
a. Drawn with AUTOCAD (latest version) to the same scale as the architectural drawings, showing device layout, raceway routing, conduit and wire size, wire identification numbers, room and floor identification numbers. These drawings shall be prepared by persons meeting the requirement of Quality Assurance paragraph. The drawings shall be stamped and signed by the contractor's engineer who shall be a licensed fire protection engineer or a licensed professional engineer in the state of California. Include the following:

b. Title Page

1) Title block showing the Installer's name, address, telephone number, license number, and NICET stamp.

2) Include an accurate legend of symbols for all fire alarm devices being installed. The legend must include the quantity and model number for each device.

3) Wire/circuit legend with circuit identification, color, gauge, wire type, number of conductors, etc.

4) A Materials Submittal cover sheet identifying all FACP equipment, model numbers, and quantities including the California State Fire Marshal listing numbers and expiration date for each component. The listing sheet shall be cross-referenced with and shall match the manufacturer's catalog data sheet.

5) Compliance Statements included on the Title Page:

   a) "The fire alarm system shall conform to Article 760 of the California Electrical Code. Installation of the fire alarm system shall not be started until detailed drawings and specifications, including current California State Fire Marshal listing sheets for each component of the fire alarm system, have been approved.

   b) A set of fire alarm shop drawings that are stamped approved shall be on the job site and used for installation. Any deviation from approved shop drawings, including substitution of devices, shall be submitted in accordance with Section 01 25 00 Substitution Procedures and approved in writing prior to installation.

   c) Any discrepancies between the drawings and the code or recognized standards shall be brought to the attention of the Engineer.

   d) Upon completion of the installation of the fire alarm system, Contractor shall coordinate with other Work to test interconnections of the fire alarm system with other building systems and equipment. Once all functions indicated in the fire alarm system sequence of operations have been verified through testing by the installing contractor, an acceptance test must be performed in the presence of the Inspector of Record. The acceptance test must successfully demonstrate all functions required in the contract.

c. Floor Plans

   1) The entire project area, room numbers and use for all rooms or spaces.

   2) All fire rated walls, clearly identified within the project area.
3) Indicate all (new and existing) final fire alarm device outlet locations.
4) Show size and route of cable and conduits.
5) Wire identification: Information showing conductor types, sizes and quantities for each conduit run.
6) Device address for all addressable devices; [module: point, zone #.#.]

d. Schematic and Wiring Sheets
1) Riser diagrams with FACP, terminal cabinets, raceway layout, circuit style and identification labels (format and designations in accordance with Performance Requirements – Nameplates and Labeling paragraph), riser conduit size, and all devices; horizontal and vertical lines shall be provided to illustrate floors and zones.
2) Complete interior wiring diagrams for the fire alarm control panel and interior modules, cards and power supplies.
3) Point-to-point wiring diagrams showing interconnections between fire alarm control panels, terminal cabinets, and fire alarm devices. All installed wiring (not factory wiring harnesses) shall be indicated. All variances from typical shall be illustrated in separate diagrams.

e. Calculation Sheets
1) Alarm power requirements for all equipment in accordance with the voltage level conditions of notification devices described in Part 2 of this section.
2) Supervisory power requirements for all equipment.
3) Battery capacity calculations for all fire alarm control panels and auxiliary power supplies. Battery calculations shall include all electrical requirements of the entire fire alarm system, including the power consumption Calculation requirements in accordance with Part 2 of this section.
4) Power supply rating justification showing power requirements for each of the system power supplies. Calculation requirements in accordance with Part 2 of this section.
5) Voltage drop calculations for wiring runs indicating cumulative current draw and voltage drop from the panel to the last device in the loop. Calculation requirements as indicated in Part 2 of this section.
6) Raceway size calculations showing percentage fill in accordance with this specification.

f. Installation Detail Sheets
1) Detailed mounting installation diagrams of the control panel(s).
2) Elevation drawing showing all fire alarm equipment enclosures and raceways on the walls where they will be installed. Panels must not be higher than 6 feet and system status displays should be at eye level (+60 inches above finished floor). No equipment or raceways may be located under a cabinet containing batteries.
3) Front view of the control panel(s) and all annunciator panels.
4) FACP, labels and labeling schemes for circuits, and field devices; nameplates and messages on the control panel(s) and annunciators shall be provided in actual size (see nameplate and labeling requirements in this section).

5) Elevation details for manual pull stations and visual alarm signaling devices.

6) Details and listing numbers of through penetration fire stop systems.

7) Details on support and anchorage of any fire alarm equipment weighing over 20 pounds.

8) Dimensioned drawings of all raceways routing and crossover details showing accurately scaled layouts and spatial relationship to associated equipment and connections. These drawings shall be fully coordinated with other Work prior to submittal. Show relationship to adjacent surrounding structure. At the completion of the work, revise all shop drawings and other documentation to reflect any revisions.

g. Schedule Sheets
1) Schedule of addressable circuits and corresponding circuit lengths
2) Circuit schedules for horns, speakers, strobes, auxiliary controls.
3) Functional response matrix identifying all system responses upon activation of each type of device.
4) Annunciator text messages and device address for each addressable device as delineated in the Annunciation Section.
5) Annunciation requirements: In an addressable system, each initiating device shall annunciate at the FACP as a discrete point on an alphanumeric display. Provide descriptive alphanumeric program labels for each system-initiating device in accordance with the following format: Zone/Module/Point/Device Type/Specific Information and/or Location (and special access notes)

6) Examples:
a) Zone 107, Module 33, Point 24, MPS, 4th Fl, C-Wing, corridor by Room 432
b) Zone 66, Module 1, Point 76, Duct Detector, 7th Fl, SF-2, in Mech Room 711
c) Zone 10, Module 33, Point 10, Water flow, 3rd Fl, Tower, in Stair No. 2

E. Qualification Data: For Installer. Refer to Quality Assurance article.

F. Testing & Commissioning Procedures:
1. Comply with the submittal requirements of Section 019100 Commissioning and Section 013323 Shop Drawings, Product Data and Samples.

G. Field quality-control test reports. See Quality Assurance article.

H. As-built Record Drawings
1. While the system installation is in progress, one additional set of shop drawings will be kept at the job site with the approved Alarm Zone Sheet. This set will be designated as the As-Built Record Drawings and will be updated regularly to reflect current as built information. These drawings shall reflect the following:
   a. Changes as a result of final installation, testing, or a change to the system design.
   b. An accurate depiction of risers, raceway, conduit, all wire runs, cable identification, conduit size, location of junction boxes, terminal boxes, sources of power, devices, sensors, equipment, controlled equipment (motor starters, fans, pumps, valves, dampers, etc.)
2. One set of as-built drawings can be replaced with a fresh updated set of drawings, but there shall never be more than one active set of as-built drawings.
3. The District’s Representative shall be given access to this set of as-built drawings at all times so that progress may be reviewed and copies can be made.

I. Record Documents
   1. Comply with the requirements of Section 01 78 39 Project Record Documents.

J. Operation and Maintenance Manuals
   1. Comply with the requirements of Section 01 78 00 Close-Out Submittals.
   2. Comply with NFPA 72, Appendix A. Include abbreviated operating instructions for mounting at the FACP.
   3. Submit operation and maintenance manuals including a brief description of the functions of and theory of operation of each system. Provide clear, concise and detailed operating instructions for all control functions giving the information required to properly operate the equipment and systems.
   4. Include technical data sheets, floor plans showing locations of all devices and any other pertinent information such as schematics, parts lists, adjustments and troubleshooting procedures.
   5. Include all working programs on compact disks, as well as a printed program listing with a license issued to the District (for on-site-system use) to modify and reproduce software documentation.

K. Final Completion Documentation
   1. Approval and Acceptance: Provide the Record of Completion form according to NFPA 72 to District’s Representative.
   2. Record of Completion Documents: Provide the Permanent Records according to NFPA 72 to District’s Representative.

1.7 QUALITY ASSURANCE

A. The Contractor shall design, supervise, program, test, and commission the installed system and provide warranty service in accordance with NFPA 72. The Contractor’s design shall complement the design provided by the qualified designer. A qualified designer as defined by NFPA 72 and shall have the proper training, education and experience.

B. Manufacturer Qualifications: Equipment shall only be provided from firms regularly engaged in design and manufacture of fire detection, alarm and communications systems, components and accessories, of types, sizes, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
C. Approved Equipment: Provide fire alarm materials, equipment and devices that have been constructed in accordance with the latest edition of the following publications from Underwriters Laboratories Inc. (UL), or Factory Mutual Engineering Corporation (FM). Materials shall be tested and listed and approved for fire protection service when so required by NFPA 72 or this specification.

1. UL 228 - Door Holding Devices
2. UL 464 - Audible Signal Appliances, Fifth Edition
3. UL 864 - Control Units for Fire Protective Signaling Systems, Sixth Edition
4. UL 1638 - Visual Signaling Appliances Standard
5. UL 1971 - Signaling Devices for the Hearing Impaired
6. UL Fire Protection Equipment Directory
7. UL Electrical Construction Materials Directory
8. FM P7825 Approval Guide

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Qualifications-Contractor shall meet the following qualifications, and shall submit proof within 10 days of the Notice to Proceed as described below:

1. Qualified personnel shall include, but shall not be limited to, individuals with the following qualifications:
   a. Factory trained and certified.
   b. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified (Level III minimum or Level IV)
   c. International Municipal Signal Association (IMSA) fire alarm certified.
   d. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
   e. A professional engineer, registered in the State of California.

2. Contractor must possess a C-10 Electrical State of California Contractor's License and have a minimum of 5 years experience in the business of installing fire alarm systems.

3. Contractor shall have successfully completed similar local (Northern California) jobs in scope and nature, using the proposed product line, fire alarm panel, and equipment, in other buildings over the past 3 years. For new product lines, one system shall have been completed and in service for at least 1 year.

4. Provide a list of at least 3 similar fire alarm projects valued at least at $50,000.00 performed by Contractor with its own forces within the last 3 years including for each project the following information:
   a. Name, address and phone number of project representative for person or entity for which project was performed.
   b. Date project was started.
   c. Date project was completed.
   d. The dollar amount for the project contract.
   e. Description of work performed.
5. Contractor shall be the manufacturer or a local authorized representative of the manufacturer with a proven track record of being responsive, providing accurate and complete submittals, meeting project schedules, and being prepared for system testing and acceptance.

6. Contractor shall be able to provide a fully equipped and qualified factory-trained repair technician at the job site for any request for emergency services within the time stipulated under the Guarantee paragraph. This service shall be available 24 hours a day during the term of warranty.

7. Contractor shall furnish evidence that the fire alarm equipment supplier has an experienced and effective service organization, which carries a stock of repair parts for the system to be furnished. The Contractor must be able to provide any replacement part on site within 48 hours during the warranty period. Should the Contractor fail to comply with the service requirements of this section, the District's Representative will then have the option to make the necessary repairs and back charge the Contractor without any loss of warranty or guarantee as provided by the Contract Documents.

8. Contractor shall employ the services of a factory-authorized service representative who is factory-trained and certified to supervise the field assembly and connection of components, program, pre-test, test, adjust, and commission the system.

1.8 GUARANTEE

A. Refer to 01 78 00 Close-Out Submittals and Exhibit 19 Guarantee/Warranty form.

B. Response time for emergency service shall be no longer than 2 hours from the time of notification. Response time for non-emergency service shall be no longer than 24 hours from the time of notification. These services shall be available 24 hours a day. District reserves the right to perform emergency service if Contractor does not meet response time and bill Contractor.

C. Repairs or replacements shall be completed within 48 hours of notification. For all repairs that cannot be completed after the initial response, a written plan of correction shall be submitted to the District prior to leaving the premises.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The fire alarm control equipment shall consist of a system assembled as an approved unit of regularly manufactured components, by a single manufacturer for the purposes described elsewhere in this specification. The fire alarm control equipment must have a proven track record of service and reliability in projects of similar scope to this project. Interconnecting equipment that has not been listed for interconnection, or the creation of components or system into a nonstandard unit that is not normally available from the manufacturer, is not acceptable.

B. Provide products as specified on the drawings. Substitutions of products of equal quality and performance will be allowed to be submitted for review and approval.

C. Products shall not be of a proprietary nature, unless specifically noted on the drawings. All products shall be readily available from a local supply house and shall not be required to be purchased from a manufacturer's distributor.

2.2 SYSTEM SOFTWARE
A. The CPU and Life Safety Software shall be the latest version listed by the CSFM. Time and date information will be included in all output messages.

B. The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.

2.3 FIRE ALARM CONTROL PANELS (FACP)

A. General Description
   1. Modular, power-limited design with electronic modules, UL 864 listed.
   2. Equipped with a nonvolatile memory that requires no battery backup.
   3. Addressable initiation devices that communicate device identity and status.
      a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
      b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
   4. Addressable control circuits for operation of mechanical equipment.

B. Circuits
   1. Signaling Line Circuits: NFPA 72, Class B.
      a. System Layout: Install no more than 80 percent of maximum addressable device capacity on each signaling line circuit.
   2. Notification-Appliance Circuits: NFPA 72, Class B.
   3. Actuation of alarm notification appliances shall occur within 10 seconds after the activation of an initiating device.
   4. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down. Locate addressable control module within 5 feet of control panel being controlled.

C. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.
   1. The FACP shall support horn and visual alarm circuits originating from FACP mounted hardware for each floor of the building.
      a. Provide a schedule by performing circuit load calculations considering wire length, gauge, number of devices, and FACP specifications.
      b. Do not use a single circuit for multiple floors; however, a number of circuits may be required for a single floor.
   2. Visual notification circuits shall be synchronized per circuit at each floor’s terminal cabinet.
   3. No horn or strobe circuit shall exceed 10 percent voltage loss measured at the end-of-line device. No strobe circuit shall exceed a 2.1-volt line loss measured at the end-of-line device with a 21-volt DC input at the fire alarm panel end of the circuit.
4. Calculate visual alarm (strobe) circuit capacity and line loss using the strobe’s 20-volt DC ratings.

D. Power Supply

1. General requirements: The FACP and Power Boosters shall have the following requirements:
   a. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with FIRE ALARM SYSTEM POWER.
   b. Surge Suppression: Install surge protection on normal ac power for the FACP and its accessories.
   c. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module.
   d. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
   e. Batteries: Sized with 25 percent reserve capacity for future expansion.
   f. 24-hour system backup capability plus 5 minutes of full alarm operation at the end of a 24-hour period.
   g. Charger shall be able to restore batteries to full charge within 48 hours after a complete discharge.
   h. No power supply shall be loaded to greater than 80 percent of its rated capacity. Rated capacity shall be calculated as the total load plus 25 percent future expansion.

2. Additional Requirements - FACP and Power Boosters
   a. Fire Alarm Panel Control Panel
      1) The FACP shall supervise battery and charging system.
      2) The FACP shall include trouble annunciation of high/low voltage, shorted cell and open circuits.
      3) A means of disconnecting the 120 VAC feed to the FACP for maintenance shall be provided within the FACP or in a locked enclosure within 10 feet of the FACP.
   b. Intelligent Power Supply
      1) Power supply shall have normally open trouble output contacts for monitoring by an external fire alarm system interface module.
      2) Power supply shall have supervised input circuit for external activation of alarm notification appliance circuits from fire alarm system interface module.
      3) If panel is not located in a locked or secured room, cabinet shall be provided with tamper switch on the door. Tamper switch shall be supervised by an external fire alarm system interface module. Opening of the door shall result in a trouble condition at the FACP.

E. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP after initiating devices are restored to normal.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an alarm silence light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.

3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and make a printout of the final adjusted values on the system printer.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.

H. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL STATIONS

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Single action mechanism, pull lever type. With integral addressable module arranged to communicate status (normal, alarm, or trouble) to the FACP.

2. Reset shall be accomplished with a lock and key.

3. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.

2.5 SMOKE DETECTORS/SENSORS

A. General Description

1. UL 268 listed, operating at 24-V dc, nominal.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

3. When exposed back boxes are needed for interior work use round wire mold boxes of the appropriate size.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated on the Drawings and with screw terminals for system connections.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn in a three pulse temporal pattern. System Sensor, Wheelock, Gentex, or equal.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word FIRE is engraved in minimum 1-inch-high letters on the lens. System Sensor, Wheelock, Gentex, or equal.

D. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

2.7 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled according to UL 632.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically capture one or two telephone lines and dial a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

C. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.8 FIRE ALARM TERMINAL CABINETS AND AUXILIARY CABINETS

A. Enclosures shall be NEMA Type 1 or Type 12. All panels shall be surface mounted with hinged door and latch with lock. All locks shall match FACP key. Box and front shall be steel, painted to match wall in finished areas.

B. Fire alarm terminal cabinet shall be labeled with a riveted or screwed laminated plastic nameplate indicating “FIRE ALARM TERMINAL CABINET” in 1/4 inch white letters on a red background.

C. Provide a wire schematic similar to that specified inside the cabinet door. Also, provide a schedule identifying all end of line resistors for the zone and their respective locations.

D. All end-of-line (EOL) devices shall be located in the terminal cabinet or the end of the corridor for the area served and labeled on the EOL device.

E. Provide identified terminal blocks in all terminal cabinets and auxiliary control cabinets. These blocks shall be sized to accommodate wire from 18 gauge to 10 gauge.

F. Backboards in the terminal cabinets shall be constructed of fire retardant treated 3/4 inch exterior grade plywood, painted white.

2.9 SPARES

A. Provide FACP spare equipment for 5 percent (at least two each) spare fully operational horn/strobe, smoke detectors, manual pull stations and matching bases for each of the initiating devices.

B. Provide 25 percent spare capacity for FACP I/O points.

2.10 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760 and manufacturer’s recommendations.

   1. Low-Voltage Circuits: No. 16 AWG, minimum.
   2. Line-Voltage and notification Circuits: No. 12 AWG, minimum.
3. Saddle grip connectors with lock nut are required. Can only be used in accessible areas. Seek District approval prior to including in design documents.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing
   1. Smooth ceiling spacing shall not exceed 30 feet.
   2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
   3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

C. Visible Alarm-Indicating Devices: Install adjacent to each alarm horn and at least 6 inches below the ceiling.

D. FACP:
   1. Install in a secured and locked room (such as electrical room or fire control room) with an annunciator at building point of entry.
   2. Surface mount with tops of cabinets not more than 72 inches above the finished floor.
   3. Panels shall be installed in a conditioned space between 60 and 80 degrees F.

3.2 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceway according to Section 26.05.33 Raceway and Boxes.
   1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

B. Wiring Method
   1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
   2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.
   3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
   4. All wire shall be new, UL approved, marked, and brought to the job site in original packages.
   5. Wire insulation shall be one of the types required by NEC. All wires shall be sized per NEC for the load serviced. Field wiring for initiation, supervision, and signal circuits shall be stranded conductor. All wire shall be approved for fire alarm installations.
6. Pig tailing and Tee tapping is prohibited for all system circuits, except door circuits and 120 VAC.

7. Addressable signaling line circuits may be Tee tapped only in the fire alarm terminal cabinet for the floor, which that circuit serves.

8. Fire alarm system shall be wired Class B, device to device, with no splicing unless approved by the District's Representative.

9. End of line resistors shall be located in the terminal cabinet or the end of the corridor or other unassigned (public) space for the zone served.

10. Splicing when approved shall be made with a terminal strip in a labeled fire alarm cabinet, which shall be easily accessible and marked clearly on shop drawings.

11. Colors shall match when possible and the conductors shall be mechanically secured to each other so that no stress is applied to the splice.

12. Aluminum wire and solid wire are not permitted unless recommended by the manufacturer. All wire and cable type to be used must be approved.

13. Wire pulls by powered mechanical means will not be permitted.

14. Conduit shall be thoroughly cleaned of all foreign material just prior to pulling the wire or cable.

15. Lubricants shall be compounds specifically prepared for cable pulling and shall not contain petroleum or other products, which will affect cable insulation.

16. Wire that has scrapes, nicks, gouges, or crushed insulation shall not be used and must be removed.

17. Do not run low voltage energy limited wiring in the same wire-ways with, or closely parallel to, high voltage and/or switched power wiring.

18. Interposing relays shall be used for all switched power loads and shall be located such that the switched power conductors do not run in the same raceway as the interposing relay coil power or any other energy-limited low voltage conductors.

19. All wiring shall be contained in metal conduit or raceways dedicated to fire alarm service.

20. Conduit size shall be 3/4 inch minimum, except conduit up to 30 feet in length, from junction box to an individual device may be 1/2 inch. Surface mounted raceways shall be Wire mold #700 minimum, T&B, or equal (also see Section 26 05 33, Raceways and Boxes).

21. No raceway shall be filled in excess of 40 percent. Contractor shall demonstrate by performing fill calculations showing that the designs comply with these criteria.

22. Provide 6 inch by 6 inch or larger junction boxes at all junctions where four or more conduits are combined. Use of extension rings to achieve adequate space for a device or junction is not allowed.

23. The raceway system shall resemble a branch and tree configuration where the main run has limited offsets, and branch lines run perpendicular to the main run.
   a. Each device shall be connected from a junction box on the main Fire Alarm (FA) raceway so that the main raceway does not pass through a device back box.

   b. Branches shall be provided with sufficient junction boxes so that not more than three unassociated circuits pass through a device back box.

24. All raceways shall run parallel or perpendicular to walls, floors, and ceilings.
25. Raceways between FACP and terminal cabinets shall not be larger than 2-1/2 inches in diameter. Where additional capacity is needed, provided a second, third, or more raceways.

26. As a minimum, provide a single 1-1/2 inch diameter raceway between the FACP and terminal cabinets, regardless of the wire fill.

27. For surface-mounted raceway, runs shall be routed on walls out of visual sight, with vertical drops to wall-mounted devices. Submit routing proposal to University's Representative for approval prior to installation.

28. Do not encase raceway in concrete unless specifically called for.

29. No wire run or circuit shall be longer than 80 percent of the maximum allowable length and power consumption for the wire size and application. No output circuit shall exceed 80 percent of the maximum load capacity specified by the manufacturer.

30. All wire terminations shall be made bare to screw terminals specifically designed for bare wire connection. Make cable shield terminations with T&B Sta-Kon, Scotchloc, or equal self-insulated spade lugs where connected to screw type terminals.

31. Wiring in all cabinets and terminal boxes shall be neatly arranged and bundled with tie wraps or equivalent.

32. Paint all junction box covers for the fire alarm system red. Paint J Box covers in finished areas to match the wall or ceiling and put a 1/2 inch minimum red dot on the cover.

33. All conduit and raceways shall be color-coded by a 3/4 inch red band at 10 foot intervals. All inductive loads (door holders, interface relays) without integral reverse Electromagnetic Field (EMF) suppression must have suppression on those circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with pressure-type terminal blocks.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors.

G. Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals according to Section 26 05 53, Identification.

B. Install instructions frame in a location visible from the FACP.

C. Paint power supply disconnect switch red and label FIRE ALARM.

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

A. General: Comply with the following requirements:

1. Engage a factory authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing. The manufacturer’s recommended testing devices shall be used.

2. Comply with the requirements of Section 01 75 00 Starting and Adjusting.

3. Comply with the requirements of Section 01 91 00 Commissioning.

4. Perform the following field tests and inspections and prepare test reports:

a. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.

b. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.

c. Include the existing system in tests and inspections.

d. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.

e. Testing: Follow procedure and record results complying with requirements in NFPA 72. In addition, perform procedures described in this article.

1) Detectors that are outside their marked sensitivity range shall be replaced.

f. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

B. Perform a test, which will be conducted by Contractor and witnessed by the District’s Representative and the Inspector of Record.

1. This test shall be completed after the system is complete and clear of troubles.

2. Should the results not be satisfactory to the District’s Representative, then corrections shall be made by Contractor and a re-test will be required at Contractor’s expense. Installer and a factory trained technician for the FACP shall be present for all testing.
3. The preliminary test shall be in accordance with a written Acceptance Test Procedure (ATP) to demonstrate and certify proper system operation. See Testing and Commissioning Procedures paragraph of this Section.

4. All detectors shall be removed from their base and checked for trouble.

5. Remove one device per signaling circuit from its box and lift a wire to test for supervision and ground. Failure due to improper system wiring will require a comprehensive test of the circuit.

6. All control switches shall be operated to indicate proper supervision of the switch.

7. All valve and sprinkler supervision switches shall be operated to verify proper response.

8. All valve and sprinkler supervision switches shall have one wire removed to verify proper supervision.

9. Each alarm output, detection, or supervision zone may be tested for proper response to ground conditions.

10. Remove all critical fuses to check for proper supervision (if applicable).

11. Test all detectors for alarm operation.

12. Test all signaling devices for proper operation. Devices that fail and are replaced will require a retest.

13. Test all alarm sounding devices for proper operation.

14. Audibility tests will be conducted by the Contractor to determine compliance with the dB requirements. Ambient readings conducted during working hour.

15. Demonstrate history log functions.

16. Confirm signal reports to UC Davis Dispatch Center.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed.

3.7 DEMONSTRATION AND TRAINING

A. General: Engage a factory-authorized service representative to train District's maintenance personnel to operate, and maintain the fire alarm system, appliances, and devices.

B. Comply with the requirements of Section 01 79 00 Demonstration and Training.

C. Contractor shall, after 2 weeks (minimum) written notification to the District's Representative, conduct a training session during which all maintenance and operational aspects of the system will be described and demonstrated to personnel selected by the District. This will include O & M Alarm personnel, and training for 3 firefighter shifts. The sessions shall be conducted by a manufacturer's representative thoroughly familiar with the characteristics of the installed system and building layout. Each individual session will be a minimum of 4 hours of instruction: 2 hrs. Classroom and 2 hrs. hands-on training at project site prior to occupancy.
SECTION 28 31 23

CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire alarm wire and cable.
   2. Identification products.

1.2 RELATED DOCUMENTS

A. Section 260519 Conductors and Cables
B. Section 260526 Grounding and Bonding
C. Section 260529 Hangers and Supports
D. Section 260553 Identification
E. Section 283100 Digital, Addressable Fire-Alarm System

1.3 APPLICABLE STANDARDS


1.4 DEFINITIONS

A. EMI: Electromagnetic interference.
B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
C. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

1.5 SUBMITTALS

A. Submit in accordance with Section 013323 Shop Drawings, Product Data, and Samples
B. Product Data: For each type of product.
C. Qualification Data: For qualified layout technician, supervisor, and field inspector.
D. Source quality-control reports.
E. Field quality-control reports.

1.6 FIELD CONDITIONS
A. Do not provide conductors and cables that are wet, moisture damaged, or mold damaged.
   1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver or provide cables and materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy level/s during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FIRE ALARM WIRE AND CABLE

A. Manufacturers:
   1. West Penn Wire.
   2. Draka Cableteq USA.
   3. Genesis Cable Products; Honeywell International, Inc.
   4. Rockbestos-Suprenant Cable Corp.
   5. Belden.
   6. Or, Equal

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 14 AWG.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

   1. Low-Voltage Circuits: No. 16 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.3 IDENTIFICATION PRODUCTS

A. Manufacturers:
   1. Brady Worldwide, Inc.
2. Kroy LLC.
4. Panduit Corp.
5. Or, Equal

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 260553 Section "Identification."

2.4 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 MOUNTING OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 260529 Hangers and Supports for Electrical Systems" for requirements of supports for cables.

3.2 WIRING METHOD

A. Provide wiring in metal pathways and wireways.
   1. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Provide cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring within Enclosures:
   1. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
   2. Provide conductors parallel with or at right angles to sides and back of enclosure.
   3. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
   4. Mark each terminal according to system's wiring diagrams.
   5. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 PLACEMENT OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:
1. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

2. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

3. Do not provide bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged and replace it with new cable.

4. Cold-Weather: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

D. Open-Cable Placement:

1. Provide cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

3. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

4. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

5. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRE ALARM WIRING PLACEMENT

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Provide wiring in metal raceway according to Section 260533 Raceways and Boxes for Electrical Systems.
1. Provide plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and Cl, is not permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables shall not be in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Provide conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Provide at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Provide number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Provide according to Section 260519 Conductors and Cables unless otherwise indicated.

B. Minimum Conductor Sizes:
1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.6 CONNECTIONS
A. Comply with requirements in Section 283111 Digital, Addressable Fire-Alarm System for connecting, terminating, and identifying wires and cables.

3.7 FIRESTOPPING

A. Comply with requirements in Section 078400 Firestopping.

3.8 GROUNDING

A. For low-voltage wiring and cabling, comply with requirements in Section 260526 Grounding and Bonding for Electrical Systems.

3.9 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with requirements for identification specified in Section 260553 Identification.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment, including connections.

END OF SECTION
DIVISIONS 29 – 30
NOT USED
SECTION 31 11 00
CLEARING AND GRUBBING

PART 1 GENERAL

1.1 SUMMARY

A. Clearing vegetation, debris, trash and other materials within limits indicated.

B. Grubbing of vegetation within limits indicated.

1.2 RELATED DOCUMENTS

A. Geotechnical Report.

B. Caltrans Standard Specifications.
   Section 16, Clearing and Grubbing.


PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 PREPARATION

A. Locate and clearly flag vegetation to remain or to be relocated.

3.2 RESTORATION

A. Repair or replace vegetation indicated to remain that is damaged by construction operations, as directed by the Owner.

B. Employ a qualified arborist, licensed in jurisdiction where the Project is located, to submit details of proposed repairs and to repair damage to shrubs.

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

B. Remove trash, debris, logs, concrete, masonry and other waste materials.

C. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

D. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18-inches below subgrade.

E. Use only hand methods for grubbing within drip line of remaining trees.

END OF SECTION
SECTION 31 23 00
EXCAVATION AND FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavation and/or embankment from existing ground to subgrade, including soil sterilant, for roadways, driveways, parking areas, walks, paths, or trails and any other site improvements called for on the Plans.

1.2 SECTION EXCLUDES

A. Earthwork related to underground utility installation, see Section 31 23 33 – Trenching and Backfilling.

1.3 RELATED SECTIONS

A. Section 02 40 00 – Demolition ( ).
B. Section 31 31 19 – Vegetation Control ( ).

1.4 RELATED DOCUMENTS

A. Geotechnical Report.
B. ASTM:
   1. D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
   2. D 1586, Method for Penetration Tests and Split-Barrel Sampling of Soils.
   3. D 2487, Classification of Soils for Engineering Purposes.
C. California Code of Regulation Title 24, Part 2, California Building Code:
   1. Chapter 11B – Accessibility to Public Buildings.
   2. Chapter 33 – Site Work, Demolition and Construction.
D. Caltrans Standard Specifications:
   1. Section 17, Watering.
2. Section 19, Earthwork.

E. CAL/OSHA, Title 8.

1.5 DEFINITIONS

A. Borrow: Approved soil material imported from off-site for use as Structural Fill or Backfill.

B. Excavation: Removal of material encountered above subgrade elevations.

   1. Authorized Over-Excavation: Excavation below subgrade elevations or beyond indicated horizontal dimensions as shown on plans or authorized by the Geotechnical Consultant.

   2. Unauthorized Over-Excavation: Excavation below subgrade elevations or beyond indicated horizontal dimensions without authorization by the Geotechnical Consultant. Unauthorized excavation shall be without additional compensation.

C. Geotechnical Testing Agency: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock definition testing, as documented according to ASTM D 3740 and ASTM E 548.

D. Structural Backfill: Soil materials approved by the Geotechnical Consultant and used to fill excavations resulting from removal of existing below grade facilities, including trees. See Section 31 23 33 – Trenching and Backfilling.

E. Structural Fill: Soil materials approved by the Geotechnical Consultant and used to raise existing grades.

F. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material ¾-cubic yards or more in volume that, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2-inches.

G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man made stationary features constructed above or below grade.

H. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, base or topsoil materials.

I. Unsuitable Material: Any soil material that is not suitable for a specific use on the Project.

J. Utilities: onsite underground pipes, conduits, ducts and cables.

1.6 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

B. Submit material certificates signed by the material producer and the Contractor, certifying that each material item complies with, or exceeds the specified requirements.

1.7 QUALITY ASSURANCE

A. Conform all work and materials to the recommendations or requirements of the Geotechnical Report and meet the approval of the Geotechnical Consultant.

B. Conform all work to the appropriate portion(s) of the California Code of Regulations, Title 24 and Caltrans Standard Specifications, Sections 17 and 19.
C. Percentage of compaction specified shall be the minimum acceptable. The percentage represents the ratio of the dry density of the compacted material to the maximum dry density of the material as determined by the procedure set forth in ASTM D 1557.

D. Perform excavation, filling, compaction and related earthwork under the observation of the Geotechnical Consultant. Materials placed without approval of the Geotechnical Consultant will be presumed to be defective and, at the discretion of the Geotechnical Consultant, shall be removed and replaced at no cost to the Owner. Notify the Geotechnical Consultant at least 24-hours prior to commencement of earthwork and at least 48 hours prior to testing.

E. The Geotechnical Consultant will perform observations and tests required to enable him to form an opinion of the acceptability of the Project earthwork. Correct earthwork that, in the opinion of the Geotechnical Consultant, does not meet the requirements of these Technical Specifications and the Geotechnical Report.

F. Upon completion of the construction work, certify that all compacted fills and foundations are in place at the correct locations, and have been constructed in accordance with sound construction practice. In addition, certify that the materials used are of the types, quality and quantity required by these Technical Specifications. The Contractor shall be responsible for the stability of all fills and backfills constructed by his forces.

G. Finish soil grade tolerance at completion of grading:

1. Building and paved areas: +0.05
2. Other areas: ±0.10 feet.

1.8 PROJECT CONDITIONS

A. Promptly notify the Owner of surface or subsurface conditions differing from those disclosed in the Geotechnical Report. First notify the Owner verbally to permit verification and extent of condition and then in writing. No claim for conditions differing from those anticipated in the Contract Documents and disclosed in the Geotechnical Report will be allowed unless the Contractor has notified the Owner in writing of differing conditions prior to the Contractor starting work on affected items.

B. Protect open excavations, trenches, and the like with fences, covers and railings to maintain safe pedestrian and vehicular traffic passage.

C. Prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

D. Temporarily stockpile fill material in an orderly and safe manner and in a location approved by the Owner.

E. Provide dust and noise control in conformance with Division 1 General Requirements.

F. Environmental Requirements: When unfavorable weather conditions necessitate interrupting earthwork operation, areas shall be prepared by compaction of surface and grading to avoid collection of water. Provide adequate temporary drainage to prevent erosion. After interruption, compaction specified in last layer shall be re-established before resuming work.
PART 2  PRODUCTS

2.1  SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from on-site excavations.

B. Obtain approval of on-site soil materials and borrow materials to be used for structural fill or structural backfill from the Geotechnical Consultant.

C. On-Site Structural Fill and Structural Backfill: Soil or soil-rock mixture from on site excavations, free from organic matter or other deleterious substances. On-site structural fill and backfill shall not contain rocks or rock fragments over 3 inches in greatest dimension, and 90% by weight shall pass the 1” sieve and with an organic content less than 3.0 percent by weight.

D. Imported Structural Fill and Structural Backfill: Conform to the requirements of on-site structural fill. Material shall also be a non-expansive and predominantly granular soil or soil-rock mixture with plasticity index of 15 or less in accordance with ASTM D 4318 and an R-Value of 25 or greater.

PART 3  EXECUTION

3.1  GENERAL

A. Conform to Section 19, Earthwork, Caltrans Standard Specifications as modified by the Contract Documents.

B. Placement and compaction of material by flooding, ponding, or jetting will not be permitted.

C. The use of explosives will not be permitted.

3.2  CONTROL OF WATER AND DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding the site and surrounding area. Provide dewatering equipment necessary to drain and keep excavations and site free from water.

B. Dewater during backfilling operation so that groundwater is maintained a least one foot below level of compaction effort.

C. Obtain the Geotechnical Consultant’s approval for proposed control of water and dewatering methods.

D. Protect subgrades from softening, undermining, washout and damage by rain or water accumulation.

E. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations.

F. Maintain dewatering system in place until dewatering is no longer required.

3.3  WET WEATHER CONDITIONS

A. Do not prepare subgrade, place or compact soil materials if above optimum moisture content.

B. If the Geotechnical Consultant allows work to continue during wetweather conditions, conform to supplemental recommendations provided by the Geotechnical Consultant.
3.4 BRACING AND SHORING

A. Conform to California and Federal OSHA requirements.

B. Place and maintain such bracing and shoring as may be required to support the sides of the excavations for the proper protection of workmen; to facilitate the work; to prevent damage to the facility being constructed; and to prevent damage to adjacent structures or facilities. Remove all bracing and shoring upon completion of the work.

C. Be solely responsible for all bracing and shoring and, if requested by the Owner, submit details and calculations to the Owner. The Owner may forward the submittal to the Geotechnical Consultant, the Consulting Engineer and/or the California Division of Industrial Safety for their review. The Contractor's submittal shall include the basic design, assumed soils conditions and estimation of forces to be resisted, together with plans and specifications of the materials and methods to be used, and shall be prepared by a civil engineer or structural engineer registered in California. No excavations related to the proposed facility shall precede a response to the submittal by the Owner.

D. Be solely responsible for installing and extracting the sheathing in a manner which will not disturb the position or operation of the facility being constructed or adjacent utilities and facilities.

3.5 EXCAVATION

A. Excavate earth and rock to lines and grades shown on drawings and to the neat dimensions indicated on the Plans, required herein or as required to satisfactorily compact backfill.

B. Remove and dispose of large rocks, pieces of concrete and other obstructions encountered during excavation.

C. Where forming is required, excavate only as much material as necessary to permit placing and removing forms.

D. Provide supports, shoring and sheet piles required to support the sides of excavations or for protection of adjacent existing improvements.

3.6 REMOVAL OF EXISTING FILLS AND UNSUITABLE MATERIAL

A. Over-excavate areas of existing fills and other unsuitable material encountered during mass grading as directed by the Geotechnical Consultant.

B. Compensation for increased removal widths and depths that are not required by the Geotechnical Consultant will not be considered, except when such increase is necessary for protection of life and property as determined by and approved by the Owner.

C. The Geotechnical Consultant will provide written approval for each excavation prior to placement of fill. Allow adequate time after excavation and before filling for the Geotechnical Consultant's review and written approval and, if necessary, time for the Owner to conduct as built survey prior to placing fill. Basis for calculating the quantity of material excavated or placed may be the difference between the grading shown on the Plan and an as built survey of the grading.

3.7 GRADING

A. Uniformly grade the Project to the elevations shown on plans.
B. Finish ditches, gutters and swales to the sections, lines and grades indicated and to permit proper surface drainage.

C. Round tops and bottoms of slopes as indicated or to blend with existing contours.

3.8 SUBGRADE PREPARATION

A. Install underground utilities and service connections prior to final preparation of subgrade and placement of base materials for final surface facilities. Extend services so that final surface facilities are not disturbed when service connections are made.

B. Prepare subgrades under paved areas, curbs, gutters, walks, structures, other surface facilities and areas to receive structural fill.

C. Prepare subgrades for paved areas, curbs and gutters by plowing or scarifying surface at least 6 inches below final subgrade elevations and 5-feet beyond edge of pavement unless specified otherwise by the Geotechnical Consultant. Uniformly moisture condition to obtain optimum moisture contents. Break clods and condition surface by harrowing or dry rolling. Remove boulders, hard ribs and solid rock. Prepare earth uniform for full depth and width of subgrade.

D. Protect utilities from damage during compaction of subgrades and until placement of final pavements or other surface facilities.

E. Obtain the Geotechnical Consultant's approval of subgrades prior to placing pavement.

3.9 PLACEMENT OF STRUCTURAL FILL

A. Obtain the Geotechnical Consultant’s approval of surface to receive structural fill prior to placement of structural fill material.

B. Place structural fill on prepared subgrade.

C. Spread structural fill material in uniform lifts not more than 8-inches in un-compacted thickness and compact.

D. Place structural fill material to suitable elevations above grade to provide for anticipated settlement and shrinkage.

E. Overbuild fill slopes, as required by the Geotechnical Consultant, to obtain required compaction. Remove excess material to lines and grades indicated.

F. Do not drop fill on structures. Do not backfill around, against or upon concrete or masonry structures until structure has attained sufficient strength to withstand loads imposed and the horizontal structural system had been installed.

3.10 KEYWAYS AND BENCHES

A. Provide keyways as indicated for fill slopes steeper than 6 horizontal to 1 vertical. Extend keyway 5-feet minimum into competent, undisturbed soil or 3-feet minimum into competent, undisturbed rock as directed by the Geotechnical Consultant.

B. Place subsurface drains in bottom of keyway in conformance with Section 33 46 00 – Subdrainage.

C. Bench subgrade as indicated above toe of fill.
D. Place subsurface drains at benches every 20 vertical feet or as directed by the Geotechnical Consultant.

3.11 LOT FINISH GRADING
A. Blade finish lots to lines and grades indicated.

3.12 COMPACTION AND TESTING
A. Do not compact by ponding, flooding or jetting.
B. Compact soils at optimum water content. Aerate material if it is too wet. Add water to material if it is too dry. Thoroughly mix lifts before compaction to ensure uniform moisture distribution.
C. Perform compaction using rollers, pneumatic or vibratory compactors or other equipment and mechanical methods approved by the Geotechnical Consultant.
D. Compaction requirements:
   1. Compact structural fills less than 5-feet thick to 90 percent compaction.
   2. Compact structural fill 5-feet thick or greater to 95 percent compaction.
   3. Compact the upper 6 inches of subgrade soils beneath pavements, curbs and gutters to 95 percent compaction. Extend compaction 5-feet beyond pavement edges unless specified otherwise by the Geotechnical Consultant.
   4. Compact the upper 6-inches of subgrade soils under walks, structures and areas to receive structural fill to 90 percent compaction.

3.13 DISPOSAL
A. Lawfully dispose of all unsuitable and excess or surplus material off-site at no cost to the Owner.

END OF SECTION
SECTION 31 23 33
TRENCHING AND BACKFILLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavation, bedding, and backfill for underground storm drain, sanitary sewer, and water piping and associated structures.

1.2 SECTION EXCLUDES

A. Drainage fill material and placement around subdrains.

B. Trenching and backfill for other utilities such as underground HVAC piping, electrical conduit, telephone conduit, gas piping, cable TV conduit, etc.

1.3 RELATED SECTIONS

A. Section 31 23 00 – Excavation and Fill.

B. Section 33 40 00 – Storm Drainage Utilities.

1.4 RELATED DOCUMENTS

A. Geotechnical Report.

B. ASTM:

1. C 33, Specification for Concrete Aggregates.


7. D 2487, Classification of Soils for Engineering Purposes.


C. California Code of Regulation Title 24, Part 2, California Building Code:

1. Chapter 11B – Accessibility to Public Buildings.
2. Chapter 33 – Site Work, Demolition and Construction.

D. Caltrans Standard Specifications:
   1. Section 19, Earthwork.
   2. Section 26, Aggregate Bases.
   3. Section 68, Subsurface Drains.
   4. Section 96, Engineering Fabrics.

E. CAL/OSHA, Title 8.

1.5 DEFINITIONS

A. AC: Asphalt Concrete.


C. Bedding: Material from bottom of trench to bottom of pipe.

D. CDF: Controlled Density Fill.

E. DIP: Ductile Iron Pipe.

F. Initial Backfill: Material from bottom of pipe to 12-inches above top of pipe.

G. PCC: Portland Cement Concrete.

H. RCP: Reinforced Concrete Pipe.

I. Springline of Pipe: Imaginary line on surface of pipe at a vertical distance of ½ the outside diameter measured from the top or bottom of the pipe.

J. Subsequent Backfill: Material from 12-inches above top of pipe to subgrade of surface material or subgrade of surface facility or to finish grade.

K. Trench Excavation: Removal of material encountered above subgrade elevations and within horizontal trench dimensions.
   1. Authorized Trench Over-Excavation: Excavation below trench subgrade elevations or beyond indicated horizontal trench dimensions as shown on plans or authorized by the Geotechnical Consultant.
   2. Unauthorized Trench Over-Excavation: Excavation below trench subgrade elevations or beyond indicated horizontal trench dimensions without authorization by the Geotechnical Consultant. Unauthorized excavation shall be without additional compensation.

L. Utility Structures:
   1. Storm drainage manholes, catch basins, drop inlets, curb inlets, vaults, etc.
   2. Sanitary sewer manholes, vaults, etc.
   3. Water vaults, etc.
1.6 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

B. Product Data:
   1. Grading and quality characteristics showing compliance with requirements for the Work.
   2. Certify that material meets requirements of the Project.

C. Samples:
   1. If required by the Geotechnical Consultant, provide 40-pound samples of all imported trench bedding and backfill material sealed in airtight containers, tagged with source locations and suppliers of each proposed material. Do not import materials to Project without written approval of the Geotechnical Consultant.
   2. Provide materials from same source throughout work. Change of source requires approval of the Geotechnical Consultant and the Owner.

1.7 QUALITY ASSURANCE

A. Conform all work and materials to the recommendations or requirements of the Geotechnical Report and meet the approval of the Geotechnical Consultant.

B. Conform all work to the appropriate portion(s) of the Caltrans Standard Specifications, Section 19.

C. Percentage of compaction specified shall be the minimum acceptable. The percentage represents the ratio of the dry density of the compacted material to the maximum dry density of the material as determined by the procedure set forth in ASTM D 1557.

D. The Geotechnical Consultant will perform observations and tests required to enable him to form an opinion of the acceptability of the trench backfill. Correct the trench backfill that, in the opinion of the Geotechnical Consultant, does not meet the requirements of these Technical Specifications and the Geotechnical Report.

E. Conform work to the requirements of the California Building Code.
   1. Section 1806A.11 – Pipe and Trenches.

1.8 PROJECT CONDITIONS

A. Promptly notify the Owner of surface or subsurface conditions differing from those disclosed in the Geotechnical Report. First notify the Owner verbally to permit verification and extent of condition and then in writing. No claim for conditions differing from those anticipated in the Contract Documents and disclosed in the Geotechnical Report will be allowed unless Contractor has notified the Owner in writing of differing conditions prior to contractor starting work on affected items.

B. Protect open, trenches, and utility structure excavations with fences, covers and railings to maintain safe pedestrian and vehicular traffic passage.

C. Stockpile on-site and imported backfill material temporarily in an orderly and safe manner.
D. Provide dust and noise control in conformance with local requirements and project storm water pollution prevention plan.

2.1 PIPE BEDDING AND INITIAL BACKFILL

A. ASTM D 2321, Class IA, IB or II.
   1. Clean and free of clay, silt or organic matter.

B. Permeable Material: Conform to Section 68-2.02F of Caltrans Standard Specifications, Class 1, Type A or Class 2.

C. Class 2 Aggregate Base: Conform to Section 26 of Caltrans Standard Specifications, ¾-inch maximum.

D. Sand: Conform to Section 19-3.02E(2) of Caltrans Standard Specifications.

2.2 WARNING TAPE

A. See Section 33 10 00 – Water Utilities.

2.3 SUBSEQUENT BACKFILL

A. Conform to on-site or imported structural backfill in Section 31 23 00 – Excavation and Fill.

2.4 CONTROLLED DENSITY FILL (CDF) (IN TRENCHES)

A. Provide non-structural CDF, from bottom of trench to finish subgrade of subbase or base material, that can be excavated by hand and produce unconfined compressive 28-day strengths from 50-psi to a maximum of 150-psi. Provide aggregate no larger than 3/8-inch top size. The 3/8-inch aggregate shall not comprise more than 30% of the total aggregate content.

B. Cement: Conform to the standards as set forth in ASTM C-150, Type II Cement.

C. Fly Ash: Conform to the standards as set forth in ASTM C-618, for Class F pozzolan. Do not inhibit the entrainment of air with the fly ash.

D. Air Entraining Agent: Conform to the standards as set forth in ASTM C-260.

E. Aggregates need not meet the standards as set forth in ASTM C-33. Any aggregate, producing performances characteristics described herein will be accepted for consideration. The amount of material passing a #200 sieve shall not exceed 12% and no plastic fines shall be present.

F. Provide CDF that is a mixture of cement, Class F pozzolan, aggregate, air entraining agent and water. CDF shall be batched by a ready mixed concrete plant and delivered to the job site by means of transit mixing trucks.

G. The Contractor shall determine the actual mix proportions of the controlled density fill to meet job site conditions, minimum and maximum strengths, and unit weight. Entrained air content shall be a minimum of 4.0%. The actual entrained air content shall be established for each job with the materials and aggregates to be used to meet the placing and unit weight requirements. Entrained air content may be as high as 20% for fluidity requirements.

H. Mix design shall meet the Geotechnical Consultant’s approval.
2.5 CONCRETE STRUCTURE BEDDING AND BACKFILL

A. Precast Structures: Same materials to the same heights as specified for pipe bedding and backfill, or other material approved by the Geotechnical Consultant.

B. Poured-in-Place Structures:
   1. Bedding: Bedding shall meet the approval of the Geotechnical Consultant. In general, bedding is not required, pour bases against undisturbed native earth in cut areas and against engineered fill compacted to 90% relative compaction in embankment areas.
   2. Side Backfill: On-site or imported structural fill meeting the requirements given in Section 31 23 00 – Excavation and Fill.

2.6 FILTER FABRIC

A. Filter Fabric:
   1. Filter Fabric: Section 96-1.02B of Caltrans Standard Specifications.
   2. Mirafi 140N (Mirafi Inc., Charlotte, NC) (Tel. 800-438-1855) or equal.

3.1 TRENCHING AND EXCAVATION

A. Existing PCC or AC Areas: Cut PCC or AC to full depth at a minimum distance of 12-inches beyond the edge of the trench.

B. Excavate by hand or machine. For gravity systems begin excavation at the outlet end and proceed upstream. Excavate sides of the trench parallel and equal distant from the centerline of the pipe. Hand trim excavation. Remove loose matter.

C. Excavation Depth for Bedding: Minimum of 4-inches below bottom of pipe or as otherwise allowed or required by the Geotechnical Consultant, except that bedding is not required for nominal pipe diameters of 2-inches or less.

D. Excavation Width at Springline of Pipe:
   1. Up to a nominal pipe diameter of 24-inches: Minimum of twice the outside pipe diameter, or as otherwise allowed or required by the Geotechnical Consultant.
   2. Nominal pipe diameter of 30-inches through 36-inches: Minimum of the outside pipe diameter plus 2-feet, or as otherwise allowed or required by the Geotechnical Consultant.
   3. Nominal pipe diameter of 42-inches through 60-inches: Minimum of the outside pipe diameter plus 3-feet, or as otherwise allowed or required by the Geotechnical Consultant.

E. Over-Excavations: Backfill trenches that have been excavated below bedding design subgrade, with approved bedding material.

F. Comply with the Owner’s limitations on the amount of trench that is opened or partially opened at any one time. Do not leave trenches open overnight without the approval of the Owner.

G. Where forming is required, excavate only as much material as necessary to permit placing and removal of forms.
H. Bottoms of trenches will be subject to testing by Geotechnical Consultant. Correct deficiencies as directed by the Geotechnical Consultant.

I. Grade bottom of trench to provide uniform thickness of bedding material and to provide uniform bearing and support for pipe along entire length. Remove stones to avoid point bearing.

3.2 CONTROL OF WATER AND DEWATERING

A. Be solely responsible for dewatering trenches and excavations and subsequent control of ground and surface water. Provide and maintain such pumps or other equipment as may be necessary to control ground water and seepage to the satisfaction of the Geotechnical Consultant and the Owner until backfilling is completed.

B. Dewater during backfilling operation so that groundwater is maintained a least one foot below level of compaction effort.

C. Obtain the Geotechnical Consultant's approval for proposed control of water and dewatering methods.

D. Reroute surface water runoff away from open trenches and excavations. Do not allow water to accumulate in trenches and excavations.

E. Maintain dewatering system in place until dewatering is no longer required.

3.3 BRACING AND SHORING

A. Conform to California and Federal OSHA requirements.

B. Place and maintain such bracing and shoring as may be required to support the sides of the excavations for the proper protection of workmen; to facilitate the work; to prevent damage to the pipes and appurtenances being constructed; and to prevent damage to adjacent structures or facilities. Remove all bracing and shoring upon completion of the work.

C. Be solely responsible for all bracing and shoring and, if requested by the Owner, submit details and calculations to the Owner. The Owner may forward the submittal to the Geotechnical Consultant, the Consulting Engineer and/or the California Division of Industrial Safety for their review. The Contractor's submittal shall include the basic design, assumed soils conditions and estimation of forces to be resisted, together with plans and specifications of the materials and methods to be used, and shall be prepared by a civil engineer or structural engineer registered in California. No excavations in trench section or around structures shall precede a response to the submittal by the Owner.

D. Be solely responsible for installing and extracting the sheathing in a manner which will not disturb the line, grade, or backfill compaction or operation of the utility being installed or adjacent utilities and facilities.

3.4 PIPE BEDDING

A. Obtain approval of bedding material from the Geotechnical Consultant.

B. Accurately shape bedding material to the line and grade called for on the Plans. Carefully place and compact bedding material to the elevation of the bottom of the pipe in layers not exceeding 8-inches in loose thickness. Compact bedding material at optimum water content to 90% relative compaction unless specified otherwise on the Plans or by the Geotechnical Consultant.
Compact by pneumatic tampers or other mechanical means approved by the Geotechnical Consultant. Jetting or ponding of bedding material will not be permitted.

C. Upon completion of bedding operations, and prior to the installation of pipe, notify the Geotechnical Consultant, who will inspect the bedding layer. Do not commence pipe laying until the Geotechnical Consultant has approved the bedding.

3.5 WARNING TAPE

A. Install in accordance with Section 33 10 00 – Water Utilities.

3.6 BACKFILLING

A. Obtain approval of backfill material from Geotechnical Consultant.

B. Bring initial backfill up simultaneously on both sides of the pipe, so as to prevent any displacement of the pipe from its true alignment. Carefully place and compact initial backfill material to an elevation of 12-inches above the top of the pipe in layers not exceeding 8-inches in loose thickness. Compact bedding material at optimum water content to 90% relative compaction unless specified otherwise on the Plans or by the Geotechnical Consultant. Compact by pneumatic tampers or other mechanical means approved by the Geotechnical Consultant. Jetting or ponding of initial backfill material will not be permitted.

C. Bring subsequent backfill to subgrade or finish grade as indicated. Carefully place and compact subsequent backfill material to the proper elevation in layers not exceeding 8-inches in loose thickness. Compact bedding material at optimum water content to 90% relative compaction, except that the upper 36-inches in areas subject to vehicular traffic shall be compacted to at least 95% relative compaction, unless specified otherwise on the Plans or by the Geotechnical Consultant. Compact by pneumatic tampers or other mechanical means approved by the Geotechnical Consultant. Jetting or ponding of subsequent backfill material will not be permitted.

D. Do not use compaction equipment or methods that produce horizontal or vertical earth pressures that may cause excessive pipe displacement or damage the pipe.

E. Utility backfill shall be inspected and tested by the Geotechnical Consultant during placement. Cooperate with the Geotechnical Consultant and provide working space for such tests in operations. Backfill not compacted in accordance with these specifications shall be re-compacted or removed as necessary and replaced to meet the specified requirements, to the satisfaction of the Geotechnical Consultant and the Owner prior to proceeding with the Project.

3.7 CLEANUP

A. Upon completion of utility earthwork all lines, manholes catch basins, inlets, water meter boxes and other structures shall be thoroughly cleaned of dirt, rubbish, debris and obstructions of any kind to the satisfaction of the Owner.

END OF SECTION
DIVISION 32
EXTERIOR IMPROVEMENTS
SECTION 32 05 23
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1  GENERAL

1.1  SECTION INCLUDES

A. Materials for portland cement concrete.
B. Aggregate and aggregate grading for portland cement concrete.
C. Water for portland cement concrete.
D. Admixtures for portland cement concrete.
E. Proportioning for portland cement concrete.
F. Mixing and transporting portland cement concrete.
G. Formwork for cast in place portland cement concrete.
H. Embedded materials for portland cement concrete.
I. Steel reinforcement for portland cement concrete.
J. Placing and finishing portland cement concrete.
K. Curing portland cement concrete.
L. Protecting portland cement concrete.

1.2  RELATED SECTIONS

A. Section 31 23 00, Excavation and Fill.
B. Section 31 31 19, Vegetation Control ( ).
C. Section 32 16 13, Concrete Curbs and Gutters.
D. Section 33 05 13, Manhole Grade Adjustment ( ).

1.3  RELATED DOCUMENTS

A. ASTM Standards
   1. A 82, Cold Drawn Steel Wire for Concrete Reinforcement.
   2. A 185, Steel Welded Wire Fabric, Plain for Concrete Reinforcement.
   3. A 615, Deformed and Plain Billet Steel Bars, for Concrete Reinforcement.
7. C 618, Fly Ash and Raw or Calcined Natural Pozzolan for use as Natural Admixture in Portland Cement.


B. Caltrans Standard Specifications:
   1. Section 51: Concrete Structures.
   2. Section 73: Concrete Curbs and Sidewalks.

C. California Building Code:
   1. Chapter 11B – Accessibility To Public Buildings.
   2. Chapter 19A – Concrete.
   4. Section 1133B – General Accessibility for Entrances, Exits and Paths of Travel.

1.4 DEFINITIONS

1.5 SUBMITTALS
   A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
   B. Design Mixes: Have all concrete mixes designed by a testing laboratory and approved by the Consulting Engineer. Conform all mixes to the applicable building code requirement, regardless of other minimum requirements listed herein or on the drawings. Submit mix designs for review before use. Show proportions and specific gravities of cement, fine and coarse aggregate, and water and gradation of combined aggregates.
   C. Reinforcing Steel Shop-Drawings

1.6 QUALITY ASSURANCE
   A. Concrete shall be subject to quality assurance in accordance with Section 90 of the Standard Specifications.
      1. Slump tests: Have available, at job site, equipment required to perform slump tests. Make one slump test for each cylinder sample, from same concrete batch. Allowable maximum slump shall be 4 inches for walls and 3 inches for slabs on grade and other work.
   B. Certifications:
      1. Provide Owner’s Representative at the time of delivery with certificates of compliance signed by both Contractor and Supplier containing the following statements:
      2. Materials contained comply with the requirements of the Contract Documents in all respects.
      3. Proportions and mixing comply with the design mix approved by the Consulting Engineer. Design mix shall have been field tested in accordance with the herein requirements of the
Caltrans Standard Specifications and produces the required compressive strength under like conditions.

4. Statement of type and amount of any admixtures.

5. Provide Owner’s Representative, at time of delivery, with certified delivery ticket stating volume of concrete delivered and time of mixing, or time of load-out in case of transit mixers.

C. Conform to the applicable provisions of Section 51, 73 and 90 of the Caltrans Standard Specification and these Technical Specifications.

1. Conform construction of portland cement concrete surface improvements (including curbs, gutters, medians, valley gutters, walks) to the requirements of Section 73 of the Caltrans Standard Specifications unless otherwise required in these Technical Specifications or shown on the Plans.

2. Construct “V” ditches in accordance with Section 72-4 of the Standard Specifications; except that finishing shall be in accordance with Standard Specification Section 73 instead of 53, or as otherwise required in these Technical Specifications or shown on the Plans.

3. Conform other construction of portland cement concrete items to the requirements of Section 51 of the Caltrans Standard Specifications unless otherwise required in these Technical Specifications or shown on the Plans.

D. Conform to the requirements of the California Building Code section 1929A.2 for testing of reinforcing bars.

1.7 DESIGNATION

A. General: Whenever the 28-day compressive strength is designated herein or on the plans is greater than 3,600 psi, the concrete shall considered to be designated by compressive strength. The 28-day compressive strength shown herein or on the plans which are 3,600 psi or less are shown for design information only and are not considered a requirement for acceptance of the concrete. Whenever the concrete is designated by class or as minor concrete herein or on the plans, the concrete shall contain the cement per cubic meter shown in section 90-1.01 of the Caltrans Standard Specifications.

B. Unless specified otherwise herein or on the Plans, Portland Cement Concrete for this Project shall be Class "2" as specified in Section 90-1.01 of the Caltrans Standard Specifications.

PART 2 PRODUCTS

2.1 GENERAL

A. For products to be installed within the jurisdiction of a local, state or federal agency, product(s) shall conform to the agency’s standard specifications.

2.2 PORTLAND CEMENT

A. General: Type V or type II (modified) cement conforming to the requirements of ASTM C 150, with the following modifications:

1. Cement shall not contain more than 0.60% by weight of alkalis, calculated as the percentage of Na₂O plus 0.658 times the percentage of K₂O when determined by either 4
intensity flame photometry or by the atomic absorption method. The instrument and procedure used shall be qualified as to precision and accuracy in accordance with the requirements of ASTM C 114.

2. The autoclave expansion shall not exceed 0.50%.

3. Mortar containing the Portland Cement to be used and the sand, when tested in accordance with Test Method No. Calif. 527, shall not expand in water more than 0.010% and shall have an air content less than .048%.

4. Allowable tri-calcium Aluminate (C₃A) by weight shall not exceed 5%. Allowable tetracalcium alumino ferrite plus twice the tricalcium aluminate (C₄AF+2C₃A) by weight shall not exceed 25%. The sulfate expansion test (ASTM C 452) may be used in lieu of the above chemical requirements, provided the sulfate expansion does not exceed 0.040% at 14 days (max.).

5. Contractor may substitute pozzolan for Portland Cement in amounts up to 15% of the required mix unless high early strength concrete is specified. Pozzolan shall consist of Class F Fly Ash meeting the requirements of ASTM C 618.

2.3 AGGREGATE AND AGGREGATE GRADING

A. General: Conform to the requirements of Section 90-1.02C of the Caltrans Standard Specifications.

B. Aggregate Size and Gradation: Conform to the requirements of section 90-1.02C of the Caltrans Standard Specifications for 25-mm (1-inch) maximum combined aggregate.

2.4 WATER

A. General: Conform to the requirements of section 90-1.02D of the Caltrans Standard Specifications, for mixing and curing portland cement concrete and for washing aggregates.

2.5 CLASSIFICATION OF PORTLAND CEMENT CONCRETE

A. Concrete for the following items shall be designated by the following classes per Section 90-1.01 of the Caltrans Standard Specifications:


2. Curbs, Gutters, and Sidewalks: Minor Concrete per Section 90-2 of the Caltrans Standard Specifications.

3. Cast in place Concrete Pipe: The concrete shall consist of a minimum of 564 pounds of Portland cement per cubic yard of concrete.

4. Thrust Blocks: The concrete shall have a minimum compressive strength of 3,000 psi.

5. Sign and Fence Footings: The concrete shall consist of a minimum of 376 pounds of Portland cement per cubic yard of concrete.


2.6 EXPANSION JOINT MATERIAL
A. Material for expansion joints in portland cement concrete improvements shall be premolded expansion joint fillers conforming to the requirements of ASTM Designation D 1751. Expansion joint material shall be shaped to fit the cross section of the concrete prior to being placed. Suppliers certificates showing conformance with this specification shall be delivered with each shipment of materials delivered to the job site. Unless noted otherwise herein or on the Plans expansion joint thickness shall be as follows:

2. Concrete Slope Protection, Gutter Lining, Ditch Lining and Channel Lining: 1/2-inch.
3. Structures: As indicated.

2.7 REINFORCEMENT AND DOWELS

A. Bar reinforcement for concrete improvements shall be deformed steel bars of the size or sizes called for on the plans conforming to the requirements of ASTM Designation A 615 for Grade 60 bars. Size and shape for bar reinforcement shall conform to the details shown or called for on the Plans. Substitution of wire mesh reinforcement for reinforcing bars will not be allowed.

B. Slip dowels, where noted or called for on the plans or detail drawings shall be smooth billet-steel bars as designated and conforming to the requirements of ASTM Designation A 615 for Grade 60 bars. Ends of bars inserted in new work shall be covered with a cardboard tube sealed with cork; no grease or oil shall be used.

C. Mesh for reinforcement for concrete improvements shall be cold drawn steel wire mesh of the size and spacing called for on the plans conforming to the requirements of ASTM Designation A 82 for the material and ASTM Designation A 185 for the mesh. Size and extent of mesh reinforcement shall conform to the details shown or called for on the plans.

D. Tie wire for reinforcement shall be eighteen (18) gauge or heavier, black, annealed conforming to the requirements of ASTM Designation A 82.

E. Suppliers certificates showing conformance with this specification shall be delivered with each shipment of materials delivered to the job site.

2.8 ACCESSORY MATERIALS

A. Conform water stops and other items required to be embedded in of Portland Cement Concrete structures to the applicable requirements of Section 51 of the Caltrans Standard Specifications unless otherwise specifically noted or called for on the Plans or detail drawings.

B. Curing Compounds:

1. Regular Portland Cement Concrete: "Non-Pigmented Curing Compound - chlorinated Rubber Base-Clear" conforming to the requirements contained in Section 90-1.02J, of the Caltrans Standard Specifications.

2.9 FORMS

A. Conform to the requirements of Section 51-1.03C(2) of the Caltrans Standard Specifications.

2.10 PRECAST CONCRETE STRUCTURES

A. Conform to the following Sections of Caltrans Standard Specifications:
1. 51-1.02, Minor Structures.
2. 70-1.02C, Flared End Sections.
3. 70-1.02H, Precast Concrete Structures.

2.11 PORTLAND CEMENT CONCRETE VEHICULAR PAVEMENT

A. General: See Section 32 13 00 – Rigid Paving.

PART 3 EXECUTION

3.1 STRUCTURAL EXCAVATION

A. Structural excavation may be either by hand, or by machine and shall be neat to the line and dimension shown or called for on the plans. Excavation shall be sufficient width to provide adequate space for working therein, and comply with CAL-OSHA requirements.

B. Where an excavation has been constructed below the design grade, refill the excavation to the bottom of the excavation grade with approved material and compact in place to 95% of the maximum dry density.

C. Remove surplus excavation material remaining upon completion of the work from the job site, or condition it to optimum moisture content and compact it as fill or backfill on the site, if the material is approved by the Geotechnical Consultant.

3.2 SOIL STERILANT

A. Furnish and apply to areas indicated in accordance with Section 31 31 19 – Vegetation Control.

3.3 BRACING AND SHORING

A. Conform to California and Federal OSHA requirements.

B. Place and maintain such bracing and shoring as may be required to support the sides of the excavations for the proper protection of workmen; to facilitate the work; to prevent damage to the facility being constructed; and to prevent damage to adjacent structures or facilities. Remove all bracing and shoring upon completion of the work.

C. Be solely responsible for all bracing and shoring and, if requested by the Owner’s Representative, submit details and calculations to the Owner’s Representative. The Owner's Representative may forward the submittal to the Geotechnical Consultant, the Consulting Engineer and/or the California Division of Industrial Safety for their review. The Contractor's submittal shall include the basic design, assumed soils conditions and estimation of forces to be resisted, together with plans and specifications of the materials and methods to be used, and shall be prepared by a civil engineer or structural engineer registered in California. No excavations related to the proposed facility shall precede a response to the submittal by the Owner's Representative.

D. Be solely responsible for installing and extracting the sheathing in a manner which will not disturb the position or operation of the facility being constructed or adjacent utilities and facilities.

3.4 PLACING CONCRETE FORMS

A. Form concrete improvements with a smooth and true upper edge. Side of the form with a smooth finish shall be placed next to concrete. Construct forms rigid enough to withstand the pressure of the fresh concrete to be placed without any distortion.
B. Thoroughly clean all forms prior to placement and coat forms with an approved form oil in sufficient quantity to prevent adherence of concrete prior to placing concrete.

C. Carefully set forms to the alignment and grade established and conform to the required dimensions. Rigidly hold forms in place by stakes set at satisfactory intervals. Provide sufficient clamps, spreaders and braces to insure the rigidity of the forms.

D. Provide forms for back and face of curbs, lip of gutters and edge of walks, valley gutters or other surface slabs that are equal to the full depth of the concrete as shown, noted or called for on the Plans. On curves and curb returns provide composite forms made from benders or thin planks of sufficient ply to ensure rigidity of the form.

3.5 PLACING STEEL REINFORCEMENT

A. Bars shall be free of mortar, oil, dirt, excessive mill scale and scabby rust and other coatings of any character that would destroy or reduce the bond. All bending shall be done cold, to the shapes shown on the plans. The length of lapped splices shall be as follows:

1. Reinforcing bars No. 8, or smaller, shall be lapped at least 45 bar diameters of the smaller bar joined, and reinforced bars Nos. 9, 10, and 11 shall be lapped at least 60 bar diameters of the smaller bars joined, except when otherwise shown on the plans.

2. Splice locations shall be made as indicated on the plans.

B. Accurately place reinforcement as shown on the plans and hold firmly and securely in position by wiring at intersections and splices, and by providing precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to resist crushing under applied loads. Provide supports and ties of such strength and density to permit walking on reinforcing without undue displacement.

C. Place reinforcing to provide the following minimum concrete cover:

1. Surfaces exposed to water: 4-inches.
2. Surfaces poured against earth: 3-inches.
3. Formed surfaces exposed to earth or weather: -inches.
4. Slabs, walls, not exposed to weather or earth: 1-inch.

D. Minimum spacing, center of parallel bars shall be two and one half (2-1/2) times the diameter of the larger sized bar. Accurately tie reinforcing securely in place prior to pouring concrete. Placing of dowels or other reinforcing in the wet concrete is not permitted.

3.6 MIXING AND TRANSPORTING PORTLAND CEMENT CONCRETE

A. Transit mix concrete in accordance with the requirements of ASTM Designation C 94. Transit mix for not less than ten (10) minutes total, not less than three (3) minutes of which shall be on the site just prior to pouring. Mix continuous with no interruptions from the time the truck is filled until the time it is emptied. Place concrete within one hour of the time water is first added unless authorized otherwise by the Owner's Representative.

B. Do not hand mix concrete for use in concrete structures.

3.7 PLACING PORTLAND CEMENT CONCRETE
A. Thoroughly wet subgrade when concrete is placed directly on soil. Remove all standing water prior to placing concrete.

B. Do not place concrete until the subgrade and the forms have been approved.

C. Convey concrete from mixer to final location as rapidly as possible by methods that prevent separation of the ingredients. Deposit concrete as nearly as possible in final position to avoid re-handling.

D. Place and solidify concrete in forms without segregation by means of mechanical vibration or by other means as approved by the Owner’s Representative. Continue vibration until the material is sufficiently consolidated and absent of all voids without causing segregation of material. The use of vibrators for extensive shifting of fresh concrete will not be permitted.

E. Concrete in certain locations may be pumped into place upon prior approval by the Owner’s Representative. When this procedure requires redesign of the mix, such redesign shall be submitted for approval in the same manner as herein specified for approval of design mixes.

3.8 PLACING ACCESSORY MATERIALS

A. Place water stops and other items required to be embedded in of portland cement concrete structures at locations shown or required in accordance with Section 51 of the Caltrans Standard Specifications unless otherwise specifically noted or called for on the Plans.

B. Curing Compounds:
   1. Regular Portland Cement Concrete: Apply "Non-Pigmented Curing Compound - chlorinated Rubber Base-Clear" in accordance with Section 90-1.02J of the Caltrans Standard Specifications.

3.9 EXPANSION JOINTS

A. Construct expansion joints incorporating premolded joint fillers at twenty (20) foot intervals in all concrete curbs, gutters, sidewalks, median/island paving, valley gutters, driveway approaches and at the ends of all returns. At each expansion joint install one-half inch by twelve inch (1/2" x 12") smooth slip dowels in the positions shown or noted on the detail drawings.

B. Orient slip dowels at right angles to the expansion joint and hold firmly in place during the construction process by means of appropriate chairs.

3.10 WEAKENED PLANE JOINTS

A. Construct weakened plane joints in concrete curbs, gutters, sidewalks, median/island paving and valley gutters between expansion joints at ten (10) foot intervals throughout, or as otherwise indicated. Depth of joint score depth to be one-fourth (25%) the thickness of the concrete.

   1. Grooved Joints: Form weakened plane joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8-inch. Repeat grooving of weakened plane joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

3.11 FINISHING CONCRETE

A. Finish curb and gutter in conformance with the applicable requirements of Section 73-2.03 of the Caltrans Standard Specifications as modified herein.
B. Where monolithic curb, gutter and sidewalk is specified, separate concrete pours will not be allowed.

C. Provide a medium broom finish to all horizontal surfaces unless otherwise shown.

3.12 FORM REMOVAL

A. Remove forms without damage to the concrete. Remove all shores and braces below the ground surface, before backfilling.

B. Do not backfill against concrete until the concrete has developed sufficient strength to prevent damage.

C. Leave forms for cast-in-place walls in place at least 72 hours after pouring.

D. Leave edge forms in place at least 24 hours after pouring.

3.13 CONSTRUCTION

A. Form, place and finish concrete walkways, island paving, valley gutters and driveway approaches in conformance with the applicable requirements of Section 73-1.03, 73-2.03 and 73-3.03 of the Caltrans Standard Specifications as modified herein.

B. Construct new concrete curb, curb and gutter and valley gutters against existing asphalt concrete by removing a minimum of 12-inches of the asphalt concrete to allow placement of curb or gutter forms. Patch pavement with a 6-inch deep lift of asphalt concrete after gutter form is removed.

3.14 CONNECTING TO EXISTING CONCRETE IMPROVEMENTS

A. New curb, gutter, or sidewalk is to connect to existing improvements to remain by saw cutting to existing sound concrete at the nearest score line, expansion joint or control joint. Drill and insert 1/2-inch diameter by 12-inch long dowels at 24-inches on center into existing improvements. Install pre-molded expansion joint filler at the matching joint.

B. A cold joint to the existing curb is not acceptable.

3.15 FIELD QUALITY CONTROL

A. Finish subgrade for concrete improvements shall be subject to approval prior to placement of forms.

B. No concrete shall be placed prior to approval of forms.

C. Concrete improvements constructed shall not contain "bird baths" or pond water and shall be smooth and ridge free.

D. Conform the finish grade at top of curb, flow line of gutter, and the finish cross section of concrete improvements to the design grades and cross sections.

E. Variation of concrete improvements from design grade and cross section as shown or called for on the plans shall not exceed the tolerances established in Section 73 of the Caltrans Standard Specifications.

3.16 RESTORATION OF EXISTING IMPROVEMENTS
A. Replace in kind all pavement or other improvements removed or damaged due to the installation of concrete improvements.

B. Remove, landscaping or plantings damaged or disturbed due to the installation of concrete improvements. Replace in kind.

END OF SECTION
SECTION 32 11 00

BASE COURSES

PART 1  GENERAL

1.1  SECTION INCLUDES

A. Aggregate subbase.
B. Aggregate base.
C. Cement treated base.

1.2  RELATED SECTIONS

A. Section 31 23 00 – Excavation and Fill.
B. Section 32 12 00 – Flexible Paving.

1.3  RELATED DOCUMENTS

A. Geotechnical Report.
B. ASTM:
   1. D 3740, Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
C. Caltrans Standard Specifications:
   1. Section 24, Lime Stabilization.
   2. Section 25, Aggregate Subbases.
   3. Section 26, Aggregate Bases.
   4. Section 27, Cement Treated Bases.

1.4  DEFINITIONS

A. Geotechnical Testing Agency: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock definition testing, as documented according to ASTM D 3740 and ASTM E 548.

B. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material ¾-cubic yards or more in volume that when tested, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2-inches.
C. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man made stationary features constructed above or below grade.

D. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, base or topsoil materials.

1.5 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

B. Submit material certificates signed by the material producer and the Contractor, certifying that that each material item complies with, or exceeds the specified requirements.

1.6 QUALITY ASSURANCE

A. Conform all work and materials to the recommendations or requirements of the Geotechnical Report and meet the approval of the Geotechnical Consultant.

B. Percentage of compaction specified shall be the minimum acceptable. The percentage represents the ratio of the dry density of the compacted material to the maximum dry density of the material as determined by the procedure set forth in ASTM D 1557.

C. Perform installation of base materials under the observation of the Geotechnical Consultant. Materials placed without approval of the Geotechnical Consultant will be presumed to be defective and, at the discretion of the Geotechnical Consultant, shall be removed and replaced at no cost to the Owner. Notify the Geotechnical Consultant at least 24-hours prior to commencement of base material installation and at least 48 hours prior to testing.

D. Do not mix or place cement treated base when the temperature is below is below 36 degrees F or when the ground is frozen.

E. Finish surface of material to be stabilized prior to lime treatment shall be as specified in Section 24-1.02 of Caltrans Standard Specifications.

F. Finish surface of the stabilized material after lime treatment shall be as specified in Section 24-2.03F of Caltrans Standard Specifications.

G. Finish surface of cement treated base shall be as specified in Section 27 of Caltrans Standard Specifications.

H. Do not project the finish surface of aggregate subbase above the design subgrade.

I. Finish grade tolerance at completion of base installation: +0.05

1.7 PROJECT CONDITIONS

A. Protect open excavations, trenches, and the like with fences, covers and railings to maintain safe pedestrian and vehicular traffic passage.

B. Temporarily stockpile material in an orderly and safe manner and in a location approved by the Owner.

C. Provide dust and noise control in conformance with Division 1 General Requirements.
PART 2 PRODUCTS

2.1 AGGREGATE SUBBASE
      1. Class 1, 2, or 3: Section 25-1.02B.
      2. Class 4: Section 25-1.02C.
      3. Class 5: Section 25-1.02D.

2.2 AGGREGATE BASE
      1. Class 2, 1-1/2-inch Maximum: Section 26-1.02B.
      2. Class 2, 3/4-inch Maximum: Section 26-1.02B.
      3. Class 3: Section 26-1.02C.

2.3 CEMENT TREATED BASE

PART 3 EXECUTION

3.1 GENERAL
   A. Placement and compaction of material by flooding, ponding, or jetting will not be permitted.

3.2 WET WEATHER CONDITIONS
   A. Do not place or compact subgrade if above optimum moisture content.
   B. If the Geotechnical Consultant allows work to continue during wet weather conditions, conform to supplemental recommendations provided by the Geotechnical Consultant.

3.3 AGGREGATE SUBBASE
   A. Spreading and Compacting: Sections 25-1.03D and 25-1.03E of Caltrans Standard Specifications.

3.4 AGGREGATE BASE
   A. Watering, Spreading and Compacting: Section 26-1.03D and 26-1.03E of Caltrans Standard Specifications.

3.5 CEMENT TREATED BASE
   A. Cement treated base shall be as follows: Proportioning and Mixing Plant-Mixed: Section 27-1.03D of Caltrans Standard Specifications.

3.6 LIME STABILIZATION
A. Performing the stabilization shall conform to Section 24-2.03 of Caltrans Standard Specifications and the following:

1. Add lime in the amount specified by the Geotechnical Consultant.

2. Lime treat subgrade soils from back of curb to back of curb to a depth specified by the Geotechnical Consultant.

3. Mix in two mixing periods, both with the tines lowered to the same depth. Both mixing periods shall be monitored and verified by a Geotechnical Consultant. The second mixing shall occur at about 24 hours after the initial mixing.

4. Compact and grade the lime mixed subgrade immediately after the second mixing.

5. Compact the lime treated subgrade to 93 percent as determined by ASTM D1557.

6. After application of the curing seal, do not allow traffic on the lime treated material for a period of 7 days in lieu of the 3 days specified in Section 24-2.03A of Caltrans Standard Specifications.

7. Proof-roll the stabilized subgrade after compacting to confirm that a non-yielding surface has been achieved. Yielding areas, if any, shall be mitigated. Mitigation could consist of over-excavation, utilization of stabilization fabric, or chemical treatment. Each case shall be addressed individually in the field by the Geotechnical Consultant.

3.7 DISPOSAL

A. Lawfully dispose of all unsuitable and excess or surplus material off-site at no cost to the Owner.

END OF SECTION
SECTION 32 12 00
FLEXIBLE PAVING

PART 1   GENERAL

1.1   SECTION INCLUDES

A. Tack coat.
B. Asphalitic concrete paving.
C. Asphalitic concrete overlay.
D. Slurry seals.
E. Speed bumps.
F. Asphalt curbs.
G. Pavement grinding.

1.2   RELATED SECTIONS

A. Section 31 31 19 – Vegetation Control ( ).
B. Section 32 11 00 – Base Courses.

1.3   RELATED DOCUMENTS

A. Geotechnical Report.

B. ASTM:


C. Caltrans Standard Specifications.
1. Section 37: Bituminous Seals.
2. Section 39: Asphalt Concrete.
4. Section 92: Asphalts.
5. Section 94: Asphaltic Emulsions.

D. California Building Code:
   1. Chapter 11B – Accessibility to Public Buildings.
   2. Section 1127B – Exterior Routes of Travel.

1.4 DEFINITIONS


1.5 QUALITY ASSURANCE

A. Testing Agency: Owner will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.
   1. Testing agency will conduct and interpret tests and state in each report whether tested work complies with or deviates from specified requirements.

B. Additional testing, at Contractor’s expense, will be performed to determine compliance of corrected Work with specified requirements.

C. Thickness of Asphaltic Concrete: In-place compacted thickness of asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Samples of uncompacted paving mixtures and compacted pavement will be secured by testing agency according to ASTM D 979.
   1. Reference maximum theoretical density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
   2. In-place density of compacted pavement may be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
      a. One core sample may be taken for every 1000 sq. yd. or less of installed pavement, but in no case will fewer than 3 cores be taken.
      b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
1.6 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

B. Job-Mix Designs: Certificates signed by manufacturers certifying that each asphaltic concrete mix complies with requirements.

C. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Tack Coat: Minimum surface temperature of 60 deg F at application.
   2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at application.
   3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at application.
   4. Reinforcing Fabric: Air temperature is 50 deg F and rising and pavement temperature is 40 deg F and rising.

PART 2 PRODUCTS

2.1 ASPHALTIC CONCRETE

A. Caltrans Standard Specifications Section 39, Type A.

B. Asphalt Materials:
      a. Asphalt Curbs: use grade PG 70-10
      b. All other asphalt products: use grade PG 64-10.
   3. Asphaltic Emulsion: Caltrans Standard Specification Section 94, quick-setting type, Grade QS1h anionic or CQS1h cationic.

C. Aggregates: Conform to Caltrans Standard Specification Sections 37-2.02C and 39-2.01B(4) as applicable.


E. Pavement Reinforcing Fabric (If indicated on drawings): Caltrans Standard Specification Section 96.

F. Sand: ASTM D 1073, Grade No. 2 or 3.
PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Notify Owner in writing of any unsatisfactory conditions. Do not begin paving until these conditions have been satisfactorily corrected.

3.2 PAVEMENT GRINDING

A. Clean existing paving surface of loose or deleterious material immediately before pavement grinding.

B. Grind conforms as indicated.

3.3 SOIL STERILANT

A. Furnish and apply to areas indicated in accordance with Section 31 31 19 – Vegetation Control.

3.4 SURFACE PREPARATION FOR AGGREGATE BASE MATERIALS

A. General: Immediately before placing asphalt materials remove loose and deleterious material from substrate surfaces and ensure that prepared subgrade is ready to receive paving according to the Caltrans Standard Specification Section 39-2.02C.

B. Tack Coat: Apply uniformly to all vertical surfaces against which asphaltic concrete is to be placed, including existing surfaces of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new asphalt pavement, according to the Caltrans Standard Specification Section 39-2.01C(3)(f).

1. Allow tack coat to cure undisturbed before paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 SURFACE PREPARATION FOR PAVEMENT AT ASPHALTIC CONCRETE OVERLAYS AND SLURRY SEALS

A. Pavement Irregularities: Level with asphaltic concrete, Type B, No. 4 maximum.

B. Pavement Cracks:

1. Less than ¼-inch wide: Clean of all dirt by compressed air jet, spray and seal with RS-1 asphaltic emulsion.

2. Wider than ¼-inch: Clean of all dirt by compressed air jet, spray and seal with RS-1 asphaltic emulsion and skin patch.

C. Clean surface of all material, such as leaves, dirt, sand, gravel, water and vegetation prior to applying binder of paving asphalt to existing surface.
3.6  PAVEMENT REINFORCING FABRIC
    A. Protect from exposure to ultraviolet rays until placed.
    B. Reject rolls with broken or damaged cores, or factory wrinkled fabric that prevents wrinkle free placement.
    C. Place with binder of paving asphalt in accordance with Section 39-2.01B(3) of Caltrans Standard Specifications.

3.7  ASPHALTIC CONCRETE SPREADING AND COMPACTING EQUIPMENT
    A. Spreading Equipment: Caltrans Standard Specification Section 39-2.01C(2).
    B. Compaction Equipment: Caltrans Standard Specification Section 39-2.01C(2).

3.8  ASPHALTIC CONCRETE PLACEMENT
    A. Place, spread and compact asphaltic concrete to required grade, cross section, and thickness according to the Caltrans Standard Specification Sections 39-2.01C(1).
    B. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.9  JOINTS
    A. Construct joints to ensure continuous bond between adjoining paving sections according to the Caltrans Standard Specification Sections 39-2.01C(4).
        1. Construct joints free of depressions with same texture and smoothness as other sections of asphalt course.
        2. Clean contact surfaces and apply tack coat.
        3. Offset longitudinal joints in successive courses a minimum of 6 inches.
        4. Offset transverse joints in successive courses a minimum of 24 inches.
        5. Compact joints as soon as asphaltic concrete will bear roller weight without excessive displacement.

3.10  COMPACTION
    A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact according to the Caltrans Standard Specification Sections 39-2.01C(2).
    B. Compaction Requirements: Average Density to be 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
    C. Finish Rolling: Finish roll paved surfaces to remove roller marks while asphalt is still warm.
D. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.

E. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh asphalt. Compact by rolling to specified density and surface smoothness.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.11 INSTALLATION TOLERANCES

A. Asphalt Pavement:

1. Course thickness and surface smoothness within the tolerances in the Caltrans Standard Specification Section 39.

2. Total Thickness: Not less than indicated.

B. Trench Patch:

1. Compacted surface: Within 0.01 foot of adjacent pavement.

2. Do not create ponding.

END OF SECTION
SECTION 32 13 00
RIGID PAVING

PART 1  GENERAL

1.1  SECTION INCLUDES

A. Furnishing, placing, spreading, compacting and shaping portland cement concrete pavement with undoweled transverse weakened plane joints, for vehicular traffic.
B. Form construction and use in placing portland cement concrete pavement.
C. Joints for portland cement concrete pavement.
D. Finishing portland cement concrete pavement.
E. Curing and protecting portland cement concrete pavement.

1.2  RELATED SECTIONS

A. Section 31 31 19 – Vegetation Control ().
B. Section 32 05 23 – Cement and Concrete for Exterior Improvements.

1.3  RELATED DOCUMENTS

A. Geotechnical Report.
B. AASHTO Standard Specifications
   1. T 53: Softening Point of Bitumen (Ring-and-Ball Apparatus).
C. ASTM Standards
   1. A 615: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   2. A 775: Epoxy Coated Reinforcing Steel Bars.
   3. A 934: Epoxy-Coated Prefabricated Steel Reinforcing Bars.
   6. D 2835: Lubricant for Installation of Preformed Compression Seals in Concrete Pavements.
   7. D 3405: Joint Sealants, Hot Poured, for Concrete and Asphalt Pavements.
   8. D 3963: Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel.
D. Caltrans Standard Specifications:
   1. Section 40, Portland Cement Concrete Pavement.
   2. Section 52, Reinforcement.
3. Section 90, Portland Cement Concrete.
4. Section 95, Epoxy.

E. Caltrans Standard Plans:
   2. Plan A35C: Portland Cement Concrete Pavement Joint and End Anchor Details.

1.4 DEFINITIONS
A. AASHTO: American Association of State Highway and Transportation Officials.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
   1. Manufacturer must be certified according to the National Ready Mix Concrete Plant Certification Program.
B. Installer Qualification: An experienced installer who has completed pavement work similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant and each aggregate from one source.

1.6 SUBMITTALS
A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results or other circumstances warrant adjustments.
C. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements.
   1. Cementitious materials and aggregates.
   2. Steel reinforcement and reinforcement accessories.
   3. Admixtures.
   4. Curing compound.
   5. Applied finish material.
   7. Joint filler.

10. Epoxy.


PART 2 PRODUCTS

2.1 PORTLAND CEMENT CONCRETE

A. General: Conform to Caltrans Standard Specifications, Section 90. Use Class 2 Concrete.

2.2 TIE BARS

A. Deformed reinforcing steel bars conforming to the requirements of ASTM Designation A 615/A (615M), Grade 40 or 60 (Grade 300 or 420).

B. Epoxy-coat in conformance with the provisions in Section 52-2.02B of Caltrans Standard Specifications.

C. Do not bend tie bars.

2.3 EPOXY

A. Bond tie bars to existing concrete with epoxy resin conforming to Section 95-1.02H, "Epoxy Resin Adhesive for Bonding New Concrete to Old Concrete," of the Caltrans Standard Specifications.

2.4 SILICONE JOINT SEALANT

A. Furnish low modulus silicone joint sealant in a one-part silicone formulation. Do not use acid cure sealants. Compound to be compatible with the surface to which it is applied and conform to the following requirements:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile stress, 150% elongation, 7-day cure at 25°± 1°C and 45% to 55% R.H.</td>
<td>ASTM D 412</td>
<td>310 kPa max.</td>
</tr>
<tr>
<td>(Die C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow at 25° ± 1°C</td>
<td>ASTM C 639a</td>
<td>Shall not flow from channel</td>
</tr>
<tr>
<td>Extrusion Rate at 25° ± 1°C</td>
<td>ASTM C 603b</td>
<td>75-250 g/min.</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>ASTM D 792</td>
<td>1.01 to 1.51</td>
</tr>
<tr>
<td>Method A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durometer Hardness, at -18°C, Shore A, cured 7 days at 25° ± 1°C</td>
<td>ASTM C 661</td>
<td>10 to 25</td>
</tr>
<tr>
<td>Ozone and Ultraviolet Resistance, after 5000 hours</td>
<td>ASTM C 793</td>
<td>No chalking, cracking or bond loss</td>
</tr>
<tr>
<td>Tack free at 25° ± 1°C and 45% to 55% R.H.</td>
<td>ASTM C 679</td>
<td>Less than 75 minutes</td>
</tr>
<tr>
<td>Property</td>
<td>Standard</td>
<td>Value</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>----------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Elongation, 7 day cure at 25° ± 1°C and 45% to 55% R.H.</td>
<td>ASTM D 412</td>
<td>500 percent min.</td>
</tr>
<tr>
<td></td>
<td>(Die C)</td>
<td></td>
</tr>
<tr>
<td>Set to Touch, at 25° ± 1°C and 45% to 55% R.H.</td>
<td>ASTM D 1640</td>
<td>Less than 75 minutes</td>
</tr>
<tr>
<td>Shelf Life, from date of shipment</td>
<td></td>
<td>6 months min.</td>
</tr>
<tr>
<td>Bond, to concrete mortar-concrete briquets, air cured 7 days at 25° ± 1°C</td>
<td>AASHTO T 132</td>
<td>345 kPa min.</td>
</tr>
<tr>
<td>Movement Capability and Adhesion, 100% extension at -18°C after, air cured 7 days at 25° ± 1°C, and followed by 7 days in water at 25° ± 1°C</td>
<td>ASTM C 719d</td>
<td>No adhesive or cohesive failure after 5 cycles</td>
</tr>
</tbody>
</table>

Notes:

- ASTM Designation: C 639 Modified (15 percent slope channel A).
- ASTM Designation: C 603, through 3-mm opening at 345 kPa.
- Mold briquets in conformance with the requirements in AASHTO Designation: T 132, sawed in half and bonded with a 1.5 mm maximum thickness of sealant and tested in conformance with the requirements in AASHTO Designation: T 132. Briquets shall be dried to constant mass at 100 ± 5°C.
- Movement Capability and Adhesion: Prepare 305 mm x 25 mm x 75 mm concrete blocks in conformance with the requirements in ASTM Designation: C 719. A sawed face shall be used for bond surface. Seal 50 mm of block leaving 12.5 mm on each end of specimen unsealed. The depth of sealant shall be 9.5 mm and the width 12.5 mm.

  e. R.H. equals relative humidity.

  B. Formulate the silicon joint sealant to cure rapidly enough to prevent flow after application on grades of up to 15 percent.

  C. Furnish to the Owner a Certificate of Compliance. Accompany certificate with a certified test report of the results of the required tests performed on the sealant material within the previous 12 months prior to proposed use. Provide the certificate and accompanying test report for each lot of silicone joint sealant prior to use on the project.

2.5 ASPHALT RUBBER JOINT SEALANT

A. Conform to the requirements of ASTM Designation: D 3405 as modified herein or to the following:

1. Provide a mixture of paving asphalt and ground rubber. Ground rubber to be vulcanized or a combination of vulcanized and de-vulcanized materials ground so that 100 percent will pass a 2.36-mm sieve and contain not less than 22 percent ground rubber, by mass. Modifiers may be used to facilitate blending.

2. The Ring and Ball softening point shall be 57°C minimum, when tested in conformance with the requirements in AASHTO Designation: T 53.

3. Provide asphalt rubber sealant material capable of being melted and applied to cracks and joints at temperatures below 204°C.

B. The penetration requirement of Section 4.2 of ASTM Designation: D 3405 do not apply. The required penetration at 25°C, 150g, 5s, shall not exceed 120.

C. The resilience requirement of Section 4.5 of ASTM Designation: D 3405 do not apply. The required resilience, when tested at 25°C, shall have a minimum of 50 percent recovery.
D. Accompany each lot of asphalt rubber joint sealant shipped to the job site, whether as specified herein or conforming to the requirements of ASTM Designation D 3405, as modified herein, by a Certificate of Compliance, storage and heating instructions and precautionary instructions for use.

E. Heat and place in conformance with the manufacturer's written instructions and the details shown on the plans. Provide manufacturer's instructions to the Owner. Do not place when the pavement surface temperature is below 10°C.

2.6 PREFORMED COMPRESSION JOINT SEALANT

   1. Number of cells: 5 or 6.
   3. Install compression seals along with lubricant adhesive according to the manufacturer's recommendations. Submit manufacture's recommendations to the Owner's Representative.

B. Accompany each lot of compression seal and lubricant adhesive by a Certificate of Compliance, storage instructions and precautionary instructions for use. Also submit the manufacturer's data sheet with installation instructions and recommended model or type of preformed compression seal for the joint size and depth as shown on the plans. Show evidence that the selected seal is being compressed at level between 20 and 50 percent at all times for the joint width and depth shown on the plans.

2.7 BACKER RODS

A. Provide backer rods that have a diameter prior to placement at least 25 percent greater than the width of the saw cut after sawing and are expanded, crosslinked, closed-cell polyethylene foam that is compatible with the joint sealant so that no bond, adverse reaction occurs between the rod and sealant. In no case use a hot pour sealant that will melt the backer rod. Submit a manufacturer's data sheet verifying that the backer rod is compatible with the sealant to be used.

PART 3 EXECUTION

3.1 WATER SUPPLY

A. Conform to Section 90-1.02D of Caltrans Standard Specifications.

3.2 SUBGRADE

A. Conform to Section 40-1.03F of Caltrans Standard Specifications.

3.3 SOIL STERILANT

A. Furnish and apply to areas indicated in accordance with Section 31 31 19 – Vegetation Control.

3.4 PLACING

A. Conform to Section 40-1.03F of Caltrans Standard Specifications.
3.5 SPREADING COMPACTING AND SHAPING

A. Conform to Section 40-1.03F of Caltrans Standard Specifications.

   1. Stationary Side Form Construction: Section 40-1.03F(4) of Caltrans Standard Specifications.
   
   2. Slip Form Construction: Section 40-1.03F(5) of Caltrans Standard Specifications.

3.6 INSTALLING TIE BARS

A. Install at longitudinal contact joints, longitudinal weakened plane joints, and transverse contact joints as shown on the plans. In no case, shall any consecutive width of new portland cement concrete pavement tied together with tie bars exceed 15 meters. In no case shall tie bars be used at a joint where portland cement concrete and asphalt concrete pavements abut.

B. Tie bars shall be installed at longitudinal joints by one of the 3 following methods:

   1. Drilling and bonding in conformance with the details shown on the plans. Provide a two-component, epoxy-resin, conforming to the requirements of ASTM Designation: C 881, Type V. Grade 3 (Non-Sagging), Class shall be as follows:

<table>
<thead>
<tr>
<th>Temperature of Concrete</th>
<th>Required Class of Epoxy Resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower than 40° F (4.5 °C)</td>
<td>A</td>
</tr>
<tr>
<td>40° F (4.5° C) through 60° F (15.5° C)</td>
<td>B</td>
</tr>
<tr>
<td>Above 60° F (15.5° C)</td>
<td>C</td>
</tr>
</tbody>
</table>

   2. Provide, at least 7 days prior to start of work, a Certificate of compliance and a copy of the manufacturer’s recommended installation procedure. The drilled holes shall be cleaned in accordance with the epoxy manufacturer’s instructions and shall be dry at the time of placing the epoxy and tie bars. Immediately after inserting the tie bars into the epoxy, the tie bars shall be supported as necessary to prevent movement during the curing and shall remain undisturbed until the epoxy has cured a minimum time as specified by the manufacturer. Tie bars that are improperly bonded, as determined by the Owner, will be rejected. If rejected, adjacent new holes shall be drilled, as directed by the Owner, and new tie bars shall be placed and securely bonded to the concrete. All work necessary to correct improperly bonded tie bars shall be performed at the Contractor’s expense.

   3. Insert the tie bars into the plastic slip-formed concrete before finishing the concrete. Inserted tie bars shall have full contact between the bar and the concrete. When tie bars are inserted through the pavement surface, the concrete over the tie bars shall be reworked and refinished to such an extent that there is no evidence on the surface of the completed pavement that there has been any insertion performed. Any loose tie bars shall be replaced by drilling and grouting into place with epoxy as described in method 1 above at the Contractor’s expense.

   4. By using threaded dowel splice couplers fabricated from deformed bar reinforcement material, free of external welding or machining. Threaded dowel splice couplers shall be accompanied by a Certificate of Compliance and installation instructions. Installation of threaded dowel splice couplers shall conform to the requirements of the manufacturer’s recommendations.
3.7 JOINTS

A. Conform to Section 40-1.03B of Caltrans Standard Specifications, Except that tie bars shall be as specified under Part 2, Products.

1. Transverse Contact Joints: Section 40-1.03B(2) of Caltrans Standard Specifications.
   a. Construct a transverse contact (construction) joint at the end of each day's work, or where concrete placement is interrupted for more than 30 minutes, to coincide with the next weakened plane joint location.
   
   b. If sufficient concrete has not been mixed to form a slab to match the next weakened plane joint, when an interruption occurs, the excess concrete shall be removed and disposed of back to the last preceding joint. The cost of removing and disposing of any excess concrete shall be at the Contractor's expense. Any excess material shall be become the property of the Contractor and shall be properly disposed of.
   
   c. A metal or wooden bulkhead (header) shall be used to form the joint. The bulkhead shall be designed to accommodate the installation of tie bars.

2. Weakened Plane Joints: Section 40-1.03B(3), except that the insert method of forming joints in pavement shall not be used.

3.8 FINISHING

A. Conform to Section 40-1.03H of Caltrans Standard Specifications.

3.9 CURING

A. Conform to Section 40-1.03I of Caltrans Standard Specifications.

3.10 SEALING JOINTS

A. Liquid Joint Sealant Installation.

1. The joint sealant detail for transverse and longitudinal joints, as shown on the plans, shall apply only to weakened plane joints. Construct weakened plane joints by the sawing method. Should grinding or grooving be required over or adjacent to any joint after sealant has been placed, completely remove the joint material and disposed of, and replace at the Contractor's expense. Recess sealant below the final finished surface as shown on the plans.

2. At the Contractor's option, transverse weakened plane joints shall be either Type DSC or Type SSC as shown on the plans. Longitudinal weakened plane joints shall be Type SSC only as shown on the plans.

3. Seven days after the concrete pavement placement and not more than 4 hours before placing backer rods and joint sealant materials, cleanse the joint walls by the dry sand blast method and other means as necessary to completely remove from the joint all objectionable material such as soil, asphalt, curing compound, paint and rust. After cleaning the joint, remove all traces of sand, dust and loose material from and near the joint for a distance along the pavement surfaces of at least 50 mm on each side of the joint by the use of a vacuum device. Remove surface moisture at the joints by means of compressed air or moderate hot compressed air or other means approved means. Do not use drying
procedures that leave a residue or film on the joint wall. Sandblasting equipment shall have a maximum nozzle diameter size of 6 ± 1 mm and a minimum pressure of 0.62-MPa.

4. Install backer rod as shown on the plans. Provide an expanded, closed-cell polyethylene foam backer rod that is compatible with the joint sealant so that no bond or adverse reaction occurs between the rod and sealant. Install backer rod when the temperature of the portland cement concrete pavement is above the dew point of the air and when the air temperature is 4°C or above. Install backer rod when the joints to be sealed have been properly patched, cleaned and dried. Do not use a method of placing backer rod that leave a residue or film on the joint walls.

5. Immediately after placement of the backer rod, place the joint sealant in the clean, dry, prepared joints as shown on the plans. Apply the joint sealant by a mechanical device with a nozzle shaped to fit inside the joint to introduce the sealant from inside the joint. Apply adequate pressure to the sealant to ensure that the sealant material is extruded evenly and that full continuous contact is made with the joint walls. After application of the sealant recess the surface of the sealant as shown on the plans.

6. Any failure of the joint material in either adhesion or cohesion of the material will be cause for rejection of the joint. Conform the finished surface of joint sealant to the dimensions and allowable tolerances shown on the plans. Rejected joint materials or joint material whose finished surface does not conform to the dimensions shown or the plans shall be repaired or replaced, at the Contractor's expense, with joint material that conforms to the requirements.

7. After each joint is sealed, remove all surplus joint sealer on the pavement surface. Traffic shall not be permitted over the sealed joints until the sealant is tack free and set sufficiently to prevent embedment of roadway debris into the sealant.

B. Preformed Compression Joint Seal Installation

1. The compression seal alternative joint detail for transverse and longitudinal joints, as shown on the plans, shall apply only to weakened plane joints. Construct weakened plane joints by the sawing method. Should grinding or grooving be required over or adjacent to any joint after the compression seal has been placed, completely remove the joint materials and disposed of, and replace at the Contractor's expense. Compression seal shall be recessed below the final finished surface as shown on the plans.

2. At the Contractor’s option, transverse weakened plane joints shall be either Type DSC or Type SSC as shown on the plans. Longitudinal weakened plane joints shall be Type SSC only as shown on the plans.

3. Seven days after the concrete pavement placement and not more than 4 hours before placing preformed compression joint seals, the joint walls by the dry sand blast method and other means as necessary to completely remove from the joint all objectionable material such as soil, asphalt, curing compound, paint and rust. After cleaning the joint, remove all traces of sand, dust and loose material from and near the joint for a distance along the pavement surfaces of at least 50 mm on each side of the joint by the use of a vacuum device. Remove surface moisture at the joints by means of compressed air or moderate hot compressed air or other means. Do not use drying procedures that leave a residue or film on the joint wall. Sandblasting equipment shall have a maximum nozzle diameter size of 6 ± 1 mm and a minimum pressure of 0.62-MPa.

3.11 PROTECTING CONCRETE PAVEMENT

A. Conform to Section 40-1.03J of Caltrans Standard Specifications.
END OF SECTION
SECTION 32 16 13
CONCRETE CURBS AND GUTTERS

PART 1   GENERAL

1.1   SECTION INCLUDES

   A. Portland Cement Concrete curbs and gutters.

1.2   RELATED SECTIONS

   A. Section 31 23 00 – Excavation and Fill.
   B. Section 31 31 19 – Vegetation Control ( ).
   C. Section 32 11 00 – Base Courses.
   D. Section 32 13 00 – Rigid Paving.
   E. Section 32 05 23 – Cement and Concrete for Exterior Improvements.

1.3   RELATED DOCUMENTS

   A. American Concrete Institute (ACI):

      1. ACI 301 - Specifications for Structural Concrete for Buildings.
      2. ACI 308 - Standard Practice for Curing Concrete.

   B. American society for Testing and Materials (ASTM):

      1. ASTM A 185 - Specification for Steel Welded Wire, Fabric, Plain, for Concrete
         Reinforcement.
      2. ASTM A 615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete
         Reinforcement.
      3. ASTM D 1751 - Specification for Preformed Expansion Joint Fillers for Concrete Paving and
         Structural Construction (Nonextruding and Resilient Bituminous Types).

   C. Caltrans Standard Specifications:

      1. Section 73: Concrete Curbs and Sidewalks.
      2. Section 90: Portland Cement Concrete.

1.4   DEFINITIONS

   A. ASTM: American Society for Testing Materials

1.5   SUBMITTALS

   A. Submittal procedures shall be as outlined in Section 01 33 00 – Submittal Procedures.

   B. Concrete Mix Design: Have all concrete mixes designed by a testing laboratory and approved by
      the Owner. Conform all mixes to the applicable building code requirement, regardless of other
minimum requirements listed herein or on the drawings. Submit mix designs for review before use. Show proportions and specific gravities of cement, fine and coarse aggregate, and water and gradation of combined aggregates.

1.6 QUALITY ASSURANCE

A. Concrete shall be subject to quality assurance in accordance with Section 90 of the Standard Specifications.

B. Certifications:

1. Provide Owner at the time of delivery with certificates of compliance signed by both Contractor and Supplier containing the following statements:

   a. Materials contained comply with the requirements of the Contract Documents in all respects.

   b. Proportions and mixing comply with the design mix approved by the Consulting Engineer. Design mix shall have been field tested in accordance with the herein requirements of the Caltrans Standard Specifications and produces the required compressive strength under like conditions.

   c. Statement of type and amount of any admixtures.

2. Provide Owner, at time of delivery, with certified delivery ticket stating volume of concrete delivered and time of mixing, or time of load-out in case of transit mixers.

C. Conform to the applicable provisions of Section 51, 73 and 90 of the Caltrans Standard Specification and these Technical Specifications.

1. Conform construction of portland cement concrete surface improvements (including curbs, gutters, medians, valley gutters, walks) to the requirements of Section 73 of the Caltrans Standard Specifications unless otherwise required in these Technical Specifications or shown on the Plans.

2. Construct "V" ditches in accordance with Section 72-4 of the Standard Specifications; except that finishing shall be in accordance with Standard Specification Section 73 instead of 53, or as otherwise required in these Technical Specifications or shown on the Plans.

1.7 DESIGNATION

A. General: Whenever the 28-day compressive strength is designated herein or on the Plans is 3,500 psi or greater, the concrete shall considered to be designated by compressive strength. The 28-day compressive strength shown herein or on the plans which are less than 3,500 psi are shown for design information only and are not considered a requirement for acceptance of the concrete. Whenever the concrete is designated by class or as minor concrete herein or on the Plans, the concrete shall contain the cement per cubic yard shown in Section 90-1.01 of the Caltrans Standard Specifications.
PART 2  PRODUCTS

2.1  GENERAL

   A. Comply with requirements of Section 32 05 23 – Cement and Concrete for Exterior Improvements.

2.2  PORTLAND CEMENT CONCRETE

   A. Unless specified otherwise herein or on the Plans, Portland Cement Concrete for items in this section shall be Minor Concrete as specified in Section 90-1.01 of the Caltrans Standard Specifications.

2.3  CURBS AND GUTTERS FORMS

   A. Use flexible spring-steel forms or laminated boards to form radius bends. Tolerance: Not to deviate more than 1/4 inch in 10 feet in grade and alignment.

2.4  EXPANSION JOINT MATERIAL

   A. Material for expansion joints in portland cement concrete improvements shall be premolded expansion joint fillers conforming to the requirements of ASTM Designation D 1751. Expansion joint material shall be shaped to fit the cross section of the concrete prior to being placed. Suppliers certificates showing conformance with this specification shall be delivered with each shipment of materials delivered to the job site.

   B. Unless noted otherwise herein or on the Plans expansion joint thickness shall be as follows:


PART 3  EXECUTION

3.1  GENERAL

   A. Comply with requirements of Section 32 05 23 – Cement and Concrete for Exterior Improvements.

   B. Form, place and finish concrete walkways, island paving, valley gutters and driveway approaches in conformance with the applicable requirements of Section 73-1.03 and 73-2.03 of the Caltrans Standard Specifications as modified herein.

   C. Construct new concrete curb, curb and gutter and valley gutters against existing asphalt concrete by removing a minimum of 12-inches of the asphalt concrete to allow placement of curb or gutter forms. Patch pavement with a 6-inch deep lift of asphalt concrete after gutter form is removed.

3.2  SUBGRADE

   A. Conform to Section 40-1.03B of Caltrans Standard Specifications.

3.3  SOIL STERILANT

   A. Furnish and apply to areas indicated in accordance with Section 31 31 19 – Vegetation Control.
3.4 PLACING CONCRETE FORMS

A. Form concrete improvements with a smooth and true upper edge. Side of the form with a smooth finish shall be placed next to concrete. Construct forms rigid enough to withstand the pressure of the fresh concrete to be placed without any distortion.

B. Thoroughly clean all forms prior to placement and coat forms with an approved form oil in sufficient quantity to prevent adherence of concrete prior to placing concrete.

C. Carefully set forms to the alignment and grade established and conform to the required dimensions. Rigidly hold forms in place by stakes set at satisfactory intervals. Provide sufficient clamps, spreaders and braces to insure the rigidity of the forms.

D. Provide forms for back and face of curbs, lip of gutters and edge of walks, valley gutters or other surface slabs that are equal to the full depth of the concrete as shown, noted or called for on the Plans. On curves and curb returns provide composite forms made from benders or thin planks of sufficient ply to ensure rigidity of the form.

3.5 PLACING STEEL REINFORCEMENT

A. Bars shall be free of mortar, oil, dirt, excessive mill scale and scabby rust and other coatings of any character that would destroy or reduce the bond.

B. Accurately place reinforcement as shown on the plans and hold firmly and securely in position by wiring at intersections and splices, and by providing precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to resist crushing under applied loads. Provide supports and ties of such strength and density to permit walking on reinforcing without undue displacement.

C. Place reinforcing to provide the following minimum concrete cover:
   1. Surfaces exposed to water: 4-inches.
   2. Surfaces poured against earth: 3-inches.
   3. Formed surfaces exposed to earth or weather: 2-inches.
   4. Slabs, walls, not exposed to weather or earth: 1-inch.

D. Minimum spacing, center of parallel bars shall be two and one half (2-1/2) times the diameter of the larger sized bar. Accurately tie reinforcing securely in place prior to pouring concrete. Placing of dowels or other reinforcing in the wet concrete is not permitted.

3.6 PLACING PORTLAND CEMENT CONCRETE

A. Thoroughly wet subgrade when concrete is placed directly on soil. Remove all standing water prior to placing concrete.

B. Do not place concrete until the subgrade and the forms have been approved.

C. Convey concrete from mixer to final location as rapidly as possible by methods that prevent separation of the ingredients. Deposit concrete as nearly as possible in final position to avoid re-handling.

D. Place and solidify concrete in forms without segregation by means of mechanical vibration or by other means as approved by the Owner. Continue vibration until the material is sufficiently
consolidated and absent of all voids without causing segregation of material. The use of vibrators for extensive shifting of fresh concrete will not be permitted.

E. Concrete in certain locations may be pumped into place upon prior approval by the Owner. When this procedure requires redesign of the mix, such redesign shall be submitted for approval in the same manner as herein specified for approval of design mixes.

3.7 EXPANSION JOINTS

A. Construct expansion joints incorporating premolded joint fillers at twenty (20) foot intervals in all concrete curbs, gutters, median/island paving, valley gutters, driveway approaches and at the ends of all returns. At each expansion joint install one-half inch by twelve inch (1/2" x 12") smooth slip dowels in the positions shown or noted on the detail drawings.

3.8 WEAKENED PLANE JOINTS

A. Construct weakened plane joints in concrete curbs, gutters, median/island paving and valley gutters between expansion joints at ten (10) foot intervals throughout, or as otherwise indicated. Depth of joint score depth to be one-fourth (25%) the thickness of the concrete.

B. Grooved Joints: Form weakened plane joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8-inch. Repeat grooving of weakened plane joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

3.9 FINISHING CONCRETE

A. Finish curb and gutter in conformance with the applicable requirements of Section 73-1.03 and 73-2.03 of the Caltrans Standard Specifications as modified herein.

B. Where monolithic curb, gutter and sidewalk is specified, separate concrete pours will not be allowed.

C. Provide a medium broom finish to all horizontal surfaces unless otherwise shown.

3.10 FORM REMOVAL

A. Remove forms without damage to the concrete. Remove all shores and braces below the ground surface, before backfilling.

B. Do not backfill against concrete until the concrete has developed sufficient strength to prevent damage.

C. Leave edge forms in place at least 24 hours after pouring.

3.11 CONNECTING TO EXISTING CONCRETE IMPROVEMENTS

A. New curb or gutter is to connect to existing improvements to remain by saw cutting to existing sound concrete at the nearest score line, expansion joint or control joint. Drill and insert ½-inch diameter by 12-inch long dowels at 24-inches on center into existing improvements. Install premolded expansion joint filler at the matching joint.

B. A cold joint to the existing curb is not acceptable.
3.12 FIELD QUALITY CONTROL

A. Conform the finish grade at top of curb, flow line of gutter, and the finish cross section of concrete improvements to the design grades and cross sections.

B. Variation of concrete improvements from design grade and cross section as shown or called for on the plans shall not exceed the tolerances established in Section 73 of the Caltrans Standard Specifications.

3.13 RESTORATION OF EXISTING IMPROVEMENTS

A. Replace in kind all pavement or other improvements removed or damaged due to the installation of concrete improvements.

B. Remove, landscaping or plantings damaged or disturbed due to the installation of concrete improvements. Replace in kind.

END OF SECTION
SECTION 32 17 23
PAVEMENT MARKINGS

PART 1  GENERAL

1.1  SECTION INCLUDES

A. Removal of existing traffic stripes and pavement markers.
B. Removal of existing signs.
C. Cleaning and sweeping of streets before application of traffic stripes and pavement markings.
D. Materials and application for traffic stripes and pavement markings.
E. Materials and application for pavement markers.
F. Traffic control signs and street name signs.
G. Object markers.
H. Survey monuments.

1.2  RELATED SECTIONS

A. Section 32 05 23 – Cement and Concrete for Exterior Improvements.

1.3  RELATED DOCUMENTS

A. Caltrans Standard Specifications:
   1. Section 56, Signs.
   2. Section 81, Monuments.
   3. Section 82, Markers and Delineators.
   4. Section 84, Traffic stripes and Pavement Markings.
   5. Section 85, Pavement Markers.

B. Caltrans Standard Plans:
   7. Plan A73B: Markers.


C. The Manual of Uniform Traffic Control Devices (MUTCD), and the California Supplement to the MUTCD, the editions in effect at time of date on plans.

D. The regulations, standards, and tests of the State of California Department of Transportation Materials and Research Division, edition in effect at time of date on plans.

1.4 QUALITY ASSURANCE

A. Deliver certificates showing conformance with this specification to the Owner with each shipment of materials and equipment to the Project site.

1.5 PROJECT CONDITIONS

A. Do not apply traffic striping or pavement markings to the pavement until after approval to proceed has been given by the Owner.

B. Thoroughly cure new asphalt concrete and portland cement concrete before application of stripes, markings or markers.

PART 2 PRODUCTS

2.1 GENERAL

A. For products to be installed within the jurisdiction of a local, state or federal agency, product(s) shall conform to the agency’s standard specifications.

2.2 THERMOPLASTIC STRIPES AND MARKING

A. Conform thermoplastic striping and marking materials to Section 84-2.02 of Caltrans Standard Specifications, unless noted otherwise herein or on the Plans.

2.3 PAINTED STRIPES AND MARKINGS

A. Conform painted striping and marking materials to Section 84-3.02 of Caltrans Standard Specifications, unless noted otherwise herein or on the Plans.

2.4 PAVEMENT Markers

A. Types: Section 85-1.02 of Caltrans Standard Specifications and as indicated.

B. Sampling, Tolerances and Packaging: Section 85-1.03 of Caltrans Standard Specifications.

C. Material


2. Retroreflective: Section 85-1.05 of Caltrans Standard Specifications.

2.5 TRAFFIC CONTROL SIGNS

A. General: Section 56-2 of the Caltrans Standard Specifications.
B. Sign Panels: Conform type (regulatory or warning), size, shape and pattern to the State of California, Department of Transportation, Traffic Manual, edition in effect at the date of the Plans. Sign faces to be of reflectorized porcelain enamel.

C. Posts:
   1. Metal: Two (2) inch inside diameter steel pipe. Conform to Section 56-2.02A of Caltrans Standard Specifications, unless otherwise specified.
   2. Wood: Conform to Section 56-2.02B.

D. Mounting Hardware: Section 56-2.02D of Caltrans Standard Specifications, unless otherwise specified.


2.6 REFLECTORIZED OBJECT MARKERS

A. ReflectORIZED Metal Object Markers: Conform to the applicable requirements of Section 82 of Caltrans Standard Specifications for target plates and reflectors, and Caltrans Standard Plan A73A for type L-1 or L-2 object markers.

B. Posts: Metal posts conforming to the applicable requirements of Section 82-1.02B of Caltrans Standard Specifications and Caltrans Standard Plan A73B.

C. Mounting Hardware: Conform to the applicable requirements of Section 82-1.02G of Caltrans Standard Specifications.

PART 3 EXECUTION

3.1 REMOVAL OF TRAFFIC STRIPES, PAVEMENT MARKINGS AND PAVEMENT MARKERS

A. Where blast cleaning is used for the removal of painted traffic stripes and pavement markings, or for removal of objectionable material, remove the residue, including dust and water, immediately after contact with the surface being treated. Remove by a vacuum attachment operating concurrently with the blast cleaning operation.

B. Where grinding is used for the removal of thermoplastic traffic stripes and pavement markings; remove the residue by means of a vacuum attachment to the grinding machine. Do not allow the residue to flow across or be left on, the pavement.

C. Where markings are to be removed by blast cleaning or by grinding, the removed area shall be approximately rectangular so that no imprint of the removed marking remains on the pavement.

D. Contractor will be responsible for repairing any damage to the pavement during removal of pavement markers. Damage to the pavement, resulting from removal of pavement markers, shall be considered as any depression more than 1/4-inch deep.

3.2 TEMPORARY PAVEMENT MARKERS

A. If permanent pavement markers cannot be installed immediately, and the street or road is to be placed in service, install short term, temporary pavement markers on the new pavement prior to opening the street or road to traffic.
B. Place markers, at a minimum, of 24 feet on centers or as required by the governmental agency having jurisdiction, in the appropriate colors to delineate centerlines and travel lanes on multi-lane roadways.

3.3 THERMOPLASTIC TRAFFIC STRIPES AND PAVEMENT MARKINGS

A. Apply in conformance with the manufacturer's instructions and the applicable requirements of Section 84-2.04 of Caltrans Standard Specifications and Caltrans Standard Plans A20A through A20D, and A24A through A24E.

3.4 PAINTED TRAFFIC STRIPES AND PAVEMENT MARKINGS

A. Apply in conformance with the manufacturer's instructions and the applicable requirements of Section 84-3.03, 3.04 and 3.05 of Caltrans Standard Specifications and Caltrans Standard Plans A20A through A20D, and A24A through A24E.

3.5 PAVEMENT MARKERS

A. Place in conformance with the requirements of Section 85-1.06 of the Caltrans Standard Specifications.

B. Pavement recesses are not required. Markers shall be installed accurately to the line established by the Engineer. No markers shall be installed until the surface has been approved by the Owner.

3.6 TRAFFIC CONTROL SIGNS

A. Install in conformance with Sections 56-2.03 and 2.04 of Caltrans Standard Specifications, Caltrans Standard Plan RS1, the applicable requirements of the State of California Department of Transportation Maintenance Manual and the details shown on the Plans. The horizontal locations shown on Caltrans Standard Plan RS1 shall not be applicable, the horizontal location shall be as shown on the Plans.

B. Portland cement concrete for post foundations shall be of the configuration shown on the Plans.

C. After erection, damage to traffic sign faces shall be touched up or the sign replaced.

3.7 STREET NAME SIGNS

A. Install in accordance with the manufacturer's instructions and as shown on the Plans.

B. Horizontal location shall be as shown on the Plans.

C. Portland cement concrete for post foundations shall be of the configuration shown on the Plans.

3.8 REFLECTORIZED OBJECT MARKERS

A. Install in conformance with the requirements of Section 82-1.03 of Caltrans Standard Specifications, except that the metal marker posts shall not be driven in place without prior approval of the Owner.

B. Install at locations shown on the Plans.

3.9 STREET SURVEY MONUMENTS

A. General: Conform to Section 81-03 of Caltrans Standard Specifications and Caltrans Standard Plan A74, except that the marker disk will not be furnished. Exact point in marker to be
determined by an accurate survey and clearly punched in top of marker together with California Registered Civil Engineer's or California Licensed Land Surveyor's license number.

3.10 PROTECTION

A. Protect the newly installed and traffic stripes and pavement markings from damage until the material has cured.

B. Replace any traffic stripes or pavement markings or markers broken, misaligned or otherwise disturbed prior to opening roadway to traffic.

3.11 RESTORATION OF EXISTING IMPROVEMENTS

A. Existing signs striping or other markings removed or damaged due to the installation of new facilities shall be replaced in kind.

B. Existing landscaping or planting removed, damaged or disturbed due to the installation of traffic control signs or street name signs shall be replaced in kind.

END OF SECTION
SECTION 32 17 26
TACTILE WARNING SURFACING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Embedded tactile warning surface tile, with an inline dome pattern, for application on ramps and level walking surfaces.

B. Tactile Tile Installation Method: As indicated on Drawings, and as follows:
   1. New Concrete: Installation in cast-in-place uncured (wet) concrete.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete.

1.3 REFERENCES

A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.

B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.

C. Referenced Standards:
   1. AASHTO HB-17 – Standard Specifications for Highway Bridges.
   3. ASTM C293 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).

1.4 SUBMITTALS

A. Submit under provisions of Division 01.

B. Shop Drawings: Show detailed plans of tile profile, fastener locations, and installation methods.

C. Samples: Furnish two tile samples, minimum 8 inches by 8 inches in size, of the type and color specified in this Section.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum five years experience.

1.6 REGULATORY REQUIREMENTS

A. General: Provide detectable (tactile) warning products in accordance with California Code of Regulations (CCR). Title 24, Part 1, 2016 California Administrative Code, Chapter 5 “Access to Public Buildings by Persons with Disabilities”.

1. Article 2 “Division of the State Architect – Access Compliance Processing Product Approvals”.

2. Article 3 “Acceptance of Detectable Warning and Directional Surface Products for Manufacturers and Design Professionals”.

3. Article 4 “Application for Independent Entity Evaluation Approval (IEEA)”.


C. Detectable Warnings for Site Accessibility: Provide detectable warning system in accordance with 2016 California Building Code, Chapter 11B, “Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing”, Section 11B-705.1, Section 11B-705.1.1.4, and the following:

1. Detectable Warnings at Curb Ramps: Chapter 11B, Section 11B-206 “Accessible Routes”, Section 11B-406.5.12, “Detectable Warnings”, and Section 11B-705.1.2.2, “Curb Ramps”.

2. Detectable Warnings at Hazardous Vehicular Areas: Chapter 11B, Section 11B-206, “Accessible Routes”, Section 11B-406.5.12, “Detectable Warnings”, and Section 11B-705.1.2.5, “Hazardous Vehicular Areas”.

3. Detectable warning surfaces shall differ from adjoining surfaces in resiliency or sound-on-cane contact per Section 11B-705.1.1.4.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle packaged products in original containers with seals unbroken and labels intact until the time of installation.
B. Store delivered products in a clean, safe, dry area.

1.8 WARRANTY

A. Five years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

   1. Provide Cast-In-Place Type Armor-Tile for embedding in cast-in-place uncured (wet) concrete.

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Tactile Warning Tiles: An epoxy polymer composite with an ultraviolet stabilized coating containing aluminum oxide particles in the truncated domes.
   1. Cast-In-Place Type Tile for Embedding in Cast-In-Place Uncured (Wet) Concrete:
      a. Tile thickness to be 0.3875 inch at domes and 0.1875 inch in flat areas between domes. Total thickness at perimeter to be 1.375 inches; dome height to be 0.20 inch.
      b. Tile underside to have embedment flanges with 0.625-inch diameter holes; long sides to have 0.1875-inch diameter vent holes.
      c. Tile to have sound amplifying plastic plates attached between flanges, with an air space between tile bottom surface and sound amplifying plastic plates.
      d. Tile face to have non-slip texture.

B. Color and Size:
   1. Safety Yellow, (Federal Color #33538 of Federal Standard 595C) colorfast, UV stabilized coating. Color shall be uniform throughout the tile.
   2. Sizes: As indicated on Drawings.

C. Performance Requirements: Tactile warning tiles shall meet or exceed the following criteria:
   1. Water Absorption: 0.05 percent, maximum, when tested in accordance with ASTM D570.
   2. Slip Resistance: 0.80, minimum combined wet/dry static coefficient of friction on top of domes and field area, when tested in accordance with ASTM C1028.
   3. Compressive Strength: 28,000 psi, minimum, when tested in accordance with ASTM D695.
   4. Tensile Strength: 19,000 psi, minimum, when tested in accordance with ASTM D638.
   5. Flexural Strength: 25,000 psi, minimum, when tested in accordance with ASTM C293.
   6. Gardner Impact: 550 inch-pounds per inch minimum, when tested in accordance with ASTM D5420.
7. Chemical Stain Resistance: No discoloration or staining when exposed to ten percent hydrochloric acid, urine, saturated calcium chloride, black stamp pad ink, chewing gum, red aerosol paint, ten percent ammonium hydroxide, one percent soap solution, turpentine, five percent Urea, diesel fuel, motor oil, and tested in accordance with ASTM D543.

8. Wear Depth: 0.06 inch, maximum, after 1000 abrasion cycles of 40 grit Norton Metallite sandpaper, tested in accordance with ASTM D2486.

9. Flame Spread: 15 maximum, when tested in accordance with ASTM E84.

10. Accelerated Weathering: No deterioration, fading or chalking, when tested for 3,000 hours in accordance with ASTM G155.

11. Accelerated Aging and Freeze Thaw Test of Tile and Adhesive System: No cracking, delamination, warping, checking, blistering, color change, loosening of tiles, or other detrimental defects, when tested in accordance with ASTM D1037.

12. Salt and Spray Performance: No evidence of deterioration or defects after 200 hours of exposure, when tested in accordance with ASTM B117.

13. AASHTO HB-17 Single Wheel HS20-44 Loading Test for Cast-In-Place Type Tile: Mounted on concrete platform with 1/2 inch air space at the underside of tile and subjected to a maximum load of 10,400 pounds, corresponding to 8000 pound individual wheel load and thirty percent impact factor; no visible damage at maximum loading.

PART 3  EXECUTION

3.1  INSTALLATION

A. Install tactile warning surface tiles in accordance with manufacturer's printed instructions.

B. Install Cast-In-Place Type tiles over cast-in-place, uncured (wet) concrete.

C. Ensure that the surfaces being prepared and fabricated to receive the tiles are constructed correctly and adequately for tile installation.

D. Installation in Cast-In-Place Uncured (Wet) Concrete: Maintain concrete in 4 inch to 7 inch slump range. Lay tactile warning surface tiles (without removing protective plastic wrap) in uncured (wet) concrete and tamp each tile in place. Place weights over tiles to prevent floating, as recommended by the manufacturer. After curing, remove protective plastic wrap, and clean tile surfaces.

END OF SECTION
SECTION 32 84 00
PLANTING IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Provide complete, automatically controlled, spray sprinkler, turf rotor, bubbler and/or drip underground irrigation system as shown on Drawings.

B. This Section includes but is not limited to: excavating, backfilling, finish grading, piping, valves, sprinklers, specialties, controls, and wiring for automatic control irrigation system.

C. Related Sections include the following:
   1. Specification Section 31 23 33 Trenching and Backfilling.
   2. Specifications Section 32 16 13 Concrete Curbs, Gutters and Sidewalks.
   3. Specification Section 32 90 00 Planting.
   5. Specification Section 32 92 00 Turf Planting.

1.3 DEFINITIONS

A. Certified Landscape Irrigation Auditor (CLIA): a person certified to perform landscape irrigation audits by the Irrigation Association Certification Board.

B. Lateral (Circuit) Piping: Downstream from control valves to sprinklers, rotors, emitters and specialties. Piping is under pressure during flow.

C. Mainline Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

D. The following are industry abbreviations for plastic materials:
1. ASME: American Society of Mechanical Engineers.
3. AWG-UF: American Wire Gauge - Underground Feeder
5. PSIG: Pounds per Square Inch Gauge.
7. SDR: Standard Direct Ratio.
8. V: Volt

1.4 PERFORMANCE REQUIREMENTS

A. Location of Sprinklers, Rotors, Emitters and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent, head to head, water coverage of turf and planting areas indicated with uniform coverage and minimum over-spray onto paving and no spray onto buildings and structures.

B. Minimum Working Pressures: The following are minimum rated pressure requirements for piping, valves, and specialties, unless otherwise indicated:
   1. Irrigation Main Piping: 200 psig.
   2. Lateral (Circuit) Piping: 150 psig.

C. Irrigation Schedule: In accordance with DSA Title 24, Part 11 – Outdoor Water Use Requirements, Contractor shall prepare two (2) – three (3) irrigation schedules, one for plant establishment, one for the established landscape and one for temporarily irrigated areas if applicable. Each schedule shall indicate the number of gallons used and shall target the Estimated Total Water Use (ETWU) and not exceed the Maximum Applied Water Allowance (MAWA) calculated on the Irrigation Plan “California Water Efficient Landscape Worksheet.” Irrigation Schedule shall be submitted at substantial completion. After acceptance of substantial completion, Contractor shall laminate schedule in plastic and place in controller enclosure prior to final completion and end of maintenance. In preparing the Irrigation Schedule, the Contractor shall consider the following:
   1. Irrigation interval (days between irrigation).
   2. Irrigation run times.
   3. Number of cycle starts to avoid runoff.
   4. Amount of applied water scheduled to be applied on a monthly basis.
   5. Application rate setting.
   6. Root depth setting.
   7. Plant type setting.
   8. Soil type.
   9. Slope factor setting.
   10. Shade factor setting.
   11. Irrigation uniformity or efficiency setting.
1.5 SUBMITTALS

A. Product and Project Data: With-in 14 days after award of the contract, furnish the Owner's Representative with submittal data on all items intended for installation. Substitute equipment or material installed without the approval of the Owner's Representative will be removed and replaced with specified items at this Contractor's expense. Submit manufacturer's technical data and installation instructions for irrigation components conforming to requirements of Division 1, Section 01 33 00 Submittal Procedures. Include pressure ratings, rated capacities, and settings of irrigation components. Submittal shall include the following:

1. Backflow device including cage and/or blanket.
2. Main, lateral (circuit) and sleeving pipe.
3. Pipe fittings, primer and cement.
4. Tracer wire and/or warning tape.
5. Isolation valves.
7. Valve boxes.
8. Sprinklers, rotors, bubblers, drip emitters.
10. Tree bubbler drain tubes.
11. Controllers. Include wiring diagrams, enclosures and mounting methods.
12. Control wires. Include splice kits and conduit.
13. Valve identification tags.
14. Irrigation Wiring Diagram: Contractor shall prepare and submit an irrigation wire diagram showing location of control wire, common wire, spare control wire and spare common wire with quantities noted at each run shown on copy of irrigation plan in a legible size and format.

15. Irrigation installation firm qualifications in accordance with "quality assurance."
16. Name and contact information of certified irrigation auditor performing irrigation audit for this project.

B. Coordination Drawings: During the course of construction, maintain orderly set of irrigation drawings and details on project site during installation of irrigation system. Record daily changes showing piping and major system components. Measure and neatly record dimensions for all mainlines, control wire runs, and all other pertinent information facilitating maintenance and extension of the irrigation system to within one (1) foot horizontally and six (6) inches vertically. Indicate interface and spatial relationship between piping, system components, adjacent utilities, and proximate structures. Up to date coordination drawings shall be available for review prior to meetings with the Owner's Representative.

C. Submittals at Substantial Completion:

1. Irrigation Record Drawings. Contractor shall record information gathered on "Coordination Drawings" onto a clean set of Irrigation Plans for documentation of as-built conditions.

2. Controller Legend: Prepare two (2) legible, reduced to 11" by 17" in size, non-fading, waterproof copy of the Record Irrigation Drawings, laminated between two (2) .020
mm (minimum) plastic sheets, printed on front side only. Attach one (1) copy to door of controller or enclosure and deliver one (1) copy to Owner. Plan sheet shall include the following information:

a. Color coded zone identification by valve.
b. Zone start time.
c. Zone water duration.
d. Type of planting irrigated.
e. Valve size, station numbers and controller designations.
f. Installing Contractor company name, contact address and phone number.

3. Contractor shall retain the services of a third party Certified Landscape Irrigation Auditor to perform a landscape irrigation water audit and prepare an irrigation audit report compliant with MWELO 492.12 including, but not limited to inspection, system tune-up, system test with distribution uniformity, correcting over-spray or run-off and configuring controllers with application rate, soil type, plant factors, slope, sun exposure and other factors necessary for accurate programming. Submit preliminary report at substantial completion, allow for adjustments during maintenance and submit report confirming irrigation installation is compliant with DSA MWELO at final completion.

4. Irrigation Schedule at substantial completion for review and approval, laminated in plastic and placed inside controller enclosure for final completion at end of maintenance period.

5. Contractor shall provide the owner with one (1) quick coupler key with hose swivel per each five (5) quick couplers.

6. Irrigation System Leak Test Results.

7. Irrigation backflow preventer certification.

8. Central control installation certification.

9. Irrigation Product Rewards – Contractor shall provide documentation to School District representative with product number (SKU) and quantities for this project if requested.

10. Operation and Maintenance Data: For irrigation systems, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include data for the following:

a. Automatic-control valves.
b. Sprinklers, rotors and/or emitters.
c. Controllers.

1.6 QUALITY ASSURANCE

A. Governing Agency Requirements:

1. For projects subject to review and approval by local governing agencies, Contractor shall comply with the State of California Model Water Efficient Landscape Ordinance at a minimum and shall conform to local codes and/or ordinances, whichever may be more stringent.
2. For projects under review of DSA, Contractor shall comply with the State of California Model Water Efficient Landscape Ordinance requirements at a minimum.

B. Installer Qualifications:

1. Experience: The irrigation installation firm shall have contracted for and successfully completed construction of a minimum of five (5) California public school district construction projects, approved by the Division of the State Architect (DSA), within the past five (5) years of similar size, complexity, budget and scope.

2. Licensure: The irrigation installation firm shall hold a current, active C27 “Landscaping Contractor” license classification by the California State License Board that has been consistently active for at least five (5) years and that has not been suspended or revoked.

3. Supervision: The irrigation installation firm shall have a qualified and experienced irrigation technician on site during irrigation installation.

4. Drip Irrigation: The irrigation installation firm shall have contracted for and successfully complete construction of a minimum of five (5) drip irrigation installations within the past five (5) years of similar size and complexity.

C. Manufacturer Qualifications: Provide underground irrigation system as a complete unit. Each type component produced by a single acceptable manufacturer, including heads, valves, controls and accessories.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Pipe crossings beneath fire Lanes: Comply with NFPA 24-10, Depth of Cover at Fire Access Lanes.

F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section “Project Management and Coordination”.

G. All work and materials shall be in strict accordance with the latest rules and regulations of the State Fire Marshall, Safety Orders of the Division of Industrial Safety, National Electrical Code, California Administrative Code, part 4, Title 24, “Basic Mechanical Regulations” and other applicable state or local laws or ordinances. Nothing in these drawings or specifications is to be construed as permitting work which does not conform to the codes or regulations.

H. Contractor shall provide all licenses, fees and other charges required for completion of the work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.
1.8 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner’s Representative no fewer than two days in advance of proposed interruption of water service.

2. Do not proceed with interruption of water service without Owner’s Representative’s written permission.

B. Interruption of Existing Irrigation Service: Do not interrupt existing to remain irrigation service. Prior to demolition work and prior to beginning irrigation work, review project site and meet with Owner Representative to review locations and connections of existing to remain irrigation system. Coordinate with General Contractor to ensure existing irrigation remains in place and operable through the duration of construction. In the event existing irrigation is shut off or damaged during construction, contractor shall provide temporary connections or modifications to continue water service to existing to remain planting material or turf to maintain in a healthy growing condition throughout construction. In the event water service is not available, contractor shall apply water through manual delivery means as necessary. Obtain approval from Owner’s Representation two days in advance of any planned disruptions in water service.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Use new materials of brands shown or Drawings, specified herein or approved equal.

B. Use existing materials if shown on Drawings.

C. Substitution of sprinklers, rotors, drip, valves and controllers will not be allowed due to variation in flows, precipitation rates, friction losses, and sizing and maintaining consistency with client equipment standards.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Schedule 40, Type S or E, Grade A or B, galvanized with threaded ends.


B. Mainline Piping, unless indicated otherwise on Drawings:
   1. Class 315 PVC pipe, ASTM D 1785, NSF approved (3" and larger)
   2. Schedule 40 PVC pipe, ASTM D 2466, NSF approved (2.5" and smaller).
   3. Fittings to be schedule 80 PVC.

C. Lateral Line Piping, unless indicated otherwise on Drawings:
   2. Fittings to be schedule 80 PVC.

D. Sleeves, unless indicated otherwise on Drawings:
   1. For irrigation piping, use schedule 40 PVC pipe, NSF approved, two, three (3) inch minimum size for irrigation piping.
   2. For irrigation wiring, use schedule 40 PVC pipe, UL listed, NEMA TC-6, ANSI/UL651, ASTM F512, for outdoor, direct bury applications, PVC, two (2) inch minimum size.
   3. Fittings to be schedule 40 PVC.

2.3 ISO\NSATION VALVES: As indicated on the drawings.

2.4 REMOTE CONTROL VALVES: As indicated on the drawings.

2.5 QUICK-COUPLING VALVES: As indicated on the drawings.

2.6 VALVE BOXES: In paved areas, use Christy or Carson concrete utility box, size as required. In planting areas, use Carson plastic underground enclosure with locking lid, bolt and washer, size as required, color per Drawings and purple for non-potable water systems. Valve boxes to be rectangular for remote control valves and ball or gate valves and round for quick coupling valves. Box lid to be labeled "IRRIGATION".

2.7 PULL BOXES AND SPLICE BOXES: In paved areas, use Christy or Carson concrete utility box, size as required. In planting areas, use Carson plastic underground enclosure with locking lid, bolt and washer, size as required, color to be green for potable water and purple for non-potable water systems. Box lid to be labeled "IRRIGATION".

2.8 SPRINKLERS AND/OR TURF ROTORS: As indicated on the drawings.

2.9 SWING JOINTS: As indicated on the drawings.

2.10 DRIP SYSTEM: As indicated on the drawings. Drip system fittings shall be of same manufacturer and/or as recommended by manufacturer.

2.11 SPRINKLER SPECIALTIES: As indicated on the drawings.

2.12 AUTOMATIC-CONTROL SYSTEM: District standard as indicated on the drawings.

2.13 AUTOMATIC CONTROLLER GROUNDING: Contractor shall install grounding recommended by manufacturer for installation method detailed on this product.

2.14 BACKFLOW PREVENTION DEVICE: As indicated on the drawings.

2.15 SPLICING MATERIALS: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.
2.16 CONNECTORS: Shall be Splice-Kote, Dura Seal heat shrink waterproof nylon wire connectors, or 3M "DBY" connectors.

2.17 TRACER WIRE: Tracer Wire: #8 solid Bare Copper Wire.

2.18 VALVE IDENTIFICATION TAGS: Shall be plastic yellow in color for potable water systems and purple in color for recycled water systems with 1 1/8” stamped black letters indicating controller/station number.

2.19 SAND BACKFILL: Shall consist of natural sand, manufactured sand, existing of native material, or combinations thereof, and shall conform to ASTM C-40 Organic Impurities, ASTM D-2419 Sand Equivalent and a pH value between 4.5 and 9.

2.20 JOINT RESTRAINTS: Leemco irrigation pipe joint restraints, or equal. Size to match mainline pipe.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 "Earthwork" for excavating, trenching, and backfilling.

B. Install piping and wiring in sleeves under sidewalks, roadways, and parking lots, and under or through footings and building walls.
   1. Install piping sleeves by boring or jacking under existing paving if possible.
   2. Install a minimum of two (2) three (3) inch diameter sleeves in each location for irrigation piping and a minimum of one (1) two (2) inch diameter electrical conduit sleeving in each location for irrigation wire.

C. Provide minimum cover over top of underground piping according to the following:
   1. Mainline piping in landscape areas: 24 inches.
   2. Lateral piping in landscape areas: 18 inches.
   3. Sleeves containing control wires, mainline and/or lateral piping beneath standard paving: 24 inches below finish surface.
   4. Sleeves containing control wires, mainline and/or lateral piping beneath vehicular paving including fire lanes/emergency vehicle access (EVA): 36 inches below finish surface.

D. Excavate trenches with vertical sides, uniform bottom, free of deleterious materials, and wide enough for pipes to lay side by side, fully supported on bottom. Minimum 3” clearance between pipes. Twelve (12”) inch minimum width for mainlines and six (6”) inch minimum width for lateral lines.

E. Trenches with irrigation pipe and/or control wiring to be backfilled with sand to 6 inches minimum above top of pipe. Continue backfilling in 6 inch layers with soil free of rocks or waste materials. Compact soil to a density equal to the surrounding undisturbed soil, but not less than 90%. Any subsequent depressions shall be filled at the Contractor’s expense. Particular attention is directed to firmly tamp and moistening around sprinkler heads and quick-couplers.
   1. For irrigation pipes three (3) inches and larger in size, install additional six (6) inch depth sand beneath piping.
F. Trenches and backfill installed under paving, asphalt concrete or concrete shall be backfilled with sand (a layer six (6) inches above the pipe) and compacted in layers equal in density to the adjacent undisturbed soil or to 90% compaction, using manual or mechanical tamping devices. All trenches shall be left flush with the adjoining grade. The Contractor shall set in place, cap and pressure test all piping under paving prior to the paving installation. Final compaction of subgrade, aggregate base and finish paving shall be completed by paving Contractor.
   1. The Contractor shall set in place, cap and pressure test pressurized mainline under paving prior to the paving installation.
   2. For irrigation pipes three (3) inches and larger in size, install additional six (6) inch depth sand beneath piping.

3.2 PREPARATION

A. Set stakes to identify locations of proposed irrigation system. Obtain Owner’s Representative’s approval before excavation.

3.3 PIPING APPLICATIONS

A. Install components having pressure rating equal to or greater than system operating pressure.

B. Piping in control valve boxes and above ground may be joined with flanges instead of joints indicated.

C. Aboveground Irrigation Main Piping: Use any of the following piping materials for each size range:
   1. NPS 4 and Smaller: Steel pipe; malleable-, gray-, or cast-iron fittings; and threaded joints.
   2. NPS 5 and Larger: Steel pipe; malleable-, gray-, or cast-iron fittings; and threaded joints.

D. Underground irrigation main piping shall be polyvinyl chloride (Type l) plastic pipe PVC 1120 and NSF approved, Schedule 40 PVC solvent-weld.

E. Underground Irrigation Lateral (Circuit) piping shall be polyvinyl chloride (Type l) plastic pipe PVC 1120 and NSF approved, schedule 40 PVC solvent-weld

F. Mainline pipe sizes 6” and larger shall use gasketed pipe with bell fittings. Where solvent weld joints are required, contractor shall additionally install concrete thrust blocking.

G. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.

H. Mainline Fittings and Couplings: Schedule 80, PVC pipe, solvent weld up to 4” and gasketed with bell fittings 6” and larger pipe.

I. Risers to Aboveground Sprinklers and Specialties: ASTM A-120 Schedule 40 galvanized steel pipe with 150 lb. banded galvanized malleable iron fittings.

J. Swing Joint Assembly:
   1. Install triple swing joint at all sprinkler heads and quick couplers.
2. Elbows shall be PVC Class 1220, Schedule 40.
3. Install as follows:
   a. Screw 2 inch long nipple horizontally into plastic tee or ell at lateral line.
   b. Screw on elbow and a 6 inch long nipple.
   c. Screw on another elbow and a 2 inch long nipple and install riser vertically to head, or quick coupler valve.
   d. Swing joint must offset to the right.

K. Sleeves: Schedule 40 PVC pipe and socket fittings; and solvent-cemented joints.

L. Transition Fittings: Use transition fittings for plastic-to-metal pipe connections according to the following:
   1. Couplings:
      a. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   2. Fittings:
      b. Underground Piping: Union with plastic end of same material as plastic piping.

M. Dielectric Fittings: Use dielectric fittings for dissimilar-metal pipe connections according to the following:
   1. Underground Piping:
      a. NPS 2 and Smaller: Dielectric couplings or dielectric nipples.
      b. NPS 2-1/2 and Larger: Prohibited except in valve box.
   2. Above ground Piping:
      a. NPS 2 and Smaller: Dielectric unions.
      b. NPS 2-1/2 to NPS 4: Dielectric flanges.
   3. Piping in Valve Boxes or Vaults:
      a. NPS 2 and Smaller: Dielectric unions.
      b. NPS 2-1/2 to NPS 4: Dielectric flanges.
   4. Dielectric fittings are specified in Division 22 Plumbing.

3.4 VALVE APPLICATIONS

A. Backflow Prevention Devices:
   1. New and relocated backflow devices must be tested at time of installation. Contractor shall have test performed by a Certified Backflow Tester who has a current State of California Contractor’s license C-36 or General Contracting License.
   2. It is the Certified Tester’s responsibility to provide results and certification to the School District within five (5) days of the date of testing and to provide any testing data or certification required by the local water provider.
   3. Install per local codes and water purveyor requirements.
B. Underground Gate/Ball Valves: Install in valve box as detailed on drawings.


D. Remote Control Valves: Install in control-valve box as detailed on drawings.

E. Drain Valves: Install in control-valve box as detailed on drawings.

F. Install each valve in a separate valve box (unless noted otherwise in Drawings and details) and in appropriate locations as shown on Drawings. Allow 12 inches between valve boxes and between valve boxes and walls or walks or landscape edges. Boxes shall be arranged perpendicular and parallel to each other and aligned in a row.

3.5 PIPING INSTALLATION

A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings. Piping shown on drawings is diagrammatic. General arrangement of piping shall be followed as near as practical. Where piping is shown running continuously in paving and adjacent to planting area, intent is to install piping within planting areas where practical.

B. Install pipe sleeves at all points where pipes pass through concrete, asphalt or masonry. In footings, allow 1 inch clearance around pipe, and in other locations allow ½ inch. Each end of sleeve shall extend 6 inches beyond edge of paving or structure above. Provide removable non-decaying plug at each end of sleeve to prevent intrusion of earth and debris.

C. If drain valves are used, install piping at minimum uniform slope of 0.5 percent down toward drain valves.

D. Install piping free of sags and vertical bends.

E. Install groups of pipes parallel to each other, spaced to permit valve servicing.

F. Install fittings for changes in direction and branch connections. Pipe bending shall not exceed manufacturer recommended radii.

G. Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 or larger pipe connection.

H. Install dielectric fittings to connect piping of dissimilar metals.

I. Install underground thermoplastic piping according to ASTM D 2774 and ASTM F 690.

J. Lay piping on solid sub-base, fully and evenly supported by bedding, uniformly sloped without humps or depressions.

K. Install PVC piping in dry weather when temperature is above 40 degrees F (5 degrees C). Allow joints to cure at least 24 hours at temperatures above 40 degrees F (5 degrees C) before testing unless otherwise recommended by manufacturer.

L. Snake pipe a minimum of one (1) additional foot per one hundred (100) feet of pipe to allow for expansion and contraction.

M. Cap or plug openings as soon as lines have been installed to prevent intrusion of debris.
N. Install concrete joint restraints, at a minimum, on pressurized mainline 3" and larger in size at changes in direction, connections or branches from mainline and dead ends and as necessary to prevent pipe movement thrusts created by internal water pressure.

O. After installation of pipe lines and sprinkler risers, and prior to installation of sprinkler heads, automatic valves and quick couplers, thoroughly flush all lines with a full head of water to remove any foreign material, scale, sediment, etc.

3.6 TRACER WIRE

A. Install as detailed along all new irrigation mainline piping on bottom of trench, carefully run to avoid stress from backfilling and shall be continuous throughout the mainline pipe runs. Fasten tracer wire to mainline at eight (8) foot intervals with tape. Take precautions to ensure tape is not damaged or misplaced during backfill operations.

B. Tracer wire shall follow mainline pipe and branch lines, originating in irrigation valve box at gate, ball or remote control valve located closest to irrigation point of connection and run to ball, gate and/or remote control valves at the end of mainline runs or shall loop entire system where mainlines are looped.

C. Record locations of tracer wire origin and terminations on project record drawings.

3.7 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Piped Utilities -- Basic Materials and Methods" for basic pipe joint construction.

B. Install threaded pipe joints as follows:
   1. Use pipe joint sealant for all plastic to plastic and plastic to steel joints, do not apply to sprinkler inlet ports.
   2. For PVC, hand tighten only. Do not over tighten threaded joints. Thread until fitting stops, then add a half turn.
   3. Use pipe joint compound and/or Teflon tape for all steel to steel joints.

C. Install gasketed joint per manufacturer recommendations (printed on pipe material) and using the lubricant supplied with the pipe.

3.8 VALVE INSTALLATION

A. Underground Gate/Ball Valves: Install in valve box as detailed on drawings.

B. Underground, Manual Control Valves: Install in manual control valve box as detailed on drawings.

C. Remote Control Valves: Install in control valve box as detailed on drawings.

D. Drain Valves: Install in control valve box as detailed on drawings.

E. Install each valve in a separate valve box (unless noted otherwise in Drawings and details) and in appropriate locations as shown on Drawings. Allow 12 inches between valve boxes and between valve boxes and walls or walks or landscape edges. Boxes shall be arranged perpendicular and parallel to each other and aligned in a row.
3.9 SPRINKLER INSTALLATION

A. Install sprinklers heads as shown on drawings and details.

B. Install plumb to finish grade.

C. Tool tighten all sprinkler body covers and nozzles.

D. Spray sprinklers shall not be installed less than 24” from non-permeable surfaces unless the adjacent non-permeable surface is constructed to drain entirely to the landscape area.

3.10 DRIP/EMITTER INSTALLATION

A. Minimum cover sub-surface drip tubing: drip and/or emitter lines shall be installed as detailed with drip tubing installed four (4) inches grade and below the mulch top dressing layer.

B. Minimum cover of tubing to individual shrubs: shrub bubbler tubing shall be installed to a depth of (4) inches and rising to the surface at target shrub rootball. No more than one (1) inch of tubing shall be exposed at shrub rootball.

C. Backfill after lines have been reviewed, tested for leaks and approved by Owner’s Representative.

D. Assembling drip system shall keep pipe and tubing free from dirt and debris, pipe ends shall be cut square, deburred and cleaned.

E. Flush piping prior to installing remote control valve assembly (control zone kit assembly).

F. Follow manufacturer recommendations.

3.11 AUTOMATIC-CONTROL SYSTEM INSTALLATION:

A. Exact location of controllers shall be reviewed and approved by Owner’s Representative.

B. Provide connection to nearest available 110 volt electrical service.

C. Prior to installation of hardscape, coordinate and install electrical supply and control wire conduit, size and quantity as required for each controller and spare wiring. Install pull boxes and conduit from clock location.

D. Control wiring shall be neatly coiled beneath controller terminal strip and labeled with corresponding station number. Controller terminal strip cover plate shall fasten securely in place.

E. Contractor is responsible to provide fully automatic system operated by specified controller(s). Contractor shall install quantity of red wiring equal to the number of stations on the specified irrigation controller(s), plus five (5) yellow spare control wires for each controller, a common white wire and a spare common black wire. Example, 24 station clock shall have 24 control wires, 5 spare control wires and 2 common wires installed with mainline and running through all associated valve boxes. Wires shall be installed per plans and details from remote control valve(s) to controller(s). Example of mainline that is not looped and terminates in 3 locations with a 24 station clock and 18 stations used:

1. Wire quantities shall be:
• 18 red control wires for stations 1-18
• 6 red control wires for un-used stations 19-24
• 1 white common wire
• 1 black spare common wire
• 5 yellow spare wires

2. Wire runs:
• 18 red control wires (stations 1-18) shall run from controller to corresponding valve.
• 6 red control wires (un-used stations 19-24) shall run from controller with 2 running down each of the 3 mainline terminations and looping through each valve box.
• 1 white common wire shall run from controller and connect to each valve associated with that controller.
• 1 black spare common wire shall run from controller and connect to each valve associated with that controller.
• 5 yellow spare control wires shall run from controller and loop through each valve box associated with that controller.

3. Contractor shall label all wires with water-proof marking with corresponding station number or as spare control wire, spare common wire or spare stations 19-24.

F. Wiring path is not shown on drawings and shall run from specified controller(s) to irrigation pull box if shown, then to the nearest irrigation mainline location, follow mainline (existing and/or new) to each remote control valve. Indicate wire location on record drawings where it does not follow mainline. Common and spare wires shall loop through entire system. Wiring may be shown on drawings only where required for future irrigation extensions.

G. Irrigation Central Control system as specified on Drawings. Contractor shall insure controller communicates properly with school district central computer and receives daily downloads for weather updates.

3.12 CONNECTIONS/ELECTRICAL WIREFING

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Ground equipment according to Division 26 Section.

C. Connect wiring according to Division 26 Section.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. 24 volt splices to be made with 3M Co. #3577 splice kit, as to manufacturer's instructions. Splices to be made only at valve box or pull box.

3.13 REMOTE CONTROL VALVE WIREFING

A. Sleeving beneath hardscape crossings: Wires shall be installed in gray UL approved electrical conduit sleeving, size and quantity as required, two (2) inch diameter minimum in size, 24" cover in planting areas and 36" cover under vehicular paving. Sufficient slack shall be left in the wire to provide for expansion and contraction.
B. Install splice boxes at splices in wire and changes in direction.

C. Wiring shall follow mainline. Wiring shall be bundled and secured to the lower side of the irrigation mainline pipe at ten (10) foot intervals with plastic electrical tape. Sufficient slack shall be left in the wire to provide for expansion and contraction.

D. Provide 24 inches excess of coil of control wires in each 100 feet of run to controller.

E. Provide 24 inches excess of coil of control wires in each valve box and pull box.

F. Control wires to be buried a minimum of 24 inches below finish grade.

G. Wires shall be installed in electrical conduit between controller and pull box. Pull box to be located in ground nearest controller. Top of box to be flush with finish grade.

H. Wiring shall be tested for continuity, open circuits and unintentional grounds prior to connecting to equipment.

3.14 LABELING AND IDENTIFYING

A. Valve Identification Tags: Install valve identification tag on each remote control valve with corresponding controller station number.

3.15 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections in the presence of the Inspector and/or Owner's Representative with 72 hours advance notice. Contractor shall record date, time, names of those present and results and submit to Owner's Representative prior to requesting substantial completion review:

1. Leak test of pressurized mainline: After installation of mainline and prior to installing remote control valves, quick coupling valves or other valve assemblies and prior to backfilling trenches, test the mainline for leaks as follows:
   a. Testing shall occur with trenches open. Center load piping with small amounts of backfill between fittings to prevent pipe displacement, arching or slipping. Fittings to be visible for testing.
   b. Exercise care in filling the system with water to prevent excessive surge pressure and water hammer
   c. Test pressurized mainline piping under hydrostatic pressure of 150 psi for eight continuous hours with no drop in pressure. Coordinate with Owner's Representative for initial observation of beginning test and observation after test.
   d. Correct deficiencies revealed by test and repeat pressure test to the satisfaction of the Owner's Representative.

2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.

3. Coverage Test: When the irrigation system has been completed, the Contractor, in the presence of the Architect and Owner's Representative, shall perform a Coverage Test to determine if the coverage of water is complete and adequate, the sprinkler heads and/or emitters function according to manufacturers' data and according to the intent of the
construction documents. Replace irrigation components not performing satisfactorily and/or repace sprinklers and/or nozzles and/or emitters as necessary to provide complete irrigation coverage of plant material.

a. For new turf areas, Contractor shall demonstrate irrigation coverage over amended planting area and prior to installation of sod and/or seeded turf.

4. Substantial Completion Review: At substantial completion of this Section, work shall be reviewed for conformance with the Drawings and Contractor shall make recommended repairs and/or corrections in a timely manner and prior to final completion.

a. At substantial completion, Contractor shall submit Certified Landscape Irrigation Auditor preliminary report on irrigation system.

b. At substantial completion, Contractor shall submit documentation per 1.5 “Submittals at Substantial Completion”.

c. At substantial completion, Contractor shall deliver spare parts to District Representative per 1.5 “Submittals at Substantial Completion”.

5. Final Completion Review: After substantial completion repairs and/or corrections have been completed and at the end of the maintenance period, work shall be reviewed for final completion and approved by Owner’s Representative in writing.

a. At final completion, Contractor shall submit Certified Landscape Irrigation Auditor final report confirming irrigation installation is compliant with DSA MWELO requirements.

3.16 CLOSING IN UN-INSPECTED WORK

A. The Contractor will pay all costs necessitated by required opening, restoration and correction of all work closed in or concealed before inspection, testing as required, and approval by authorized inspections.

3.17 STARTUP SERVICE

A. Verify that controllers are installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer’s submittal and installation requirements in Division 26 Sections.

C. Complete startup checks according to manufacturer’s written instructions.

3.18 MAINTENANCE SCHEDULE

A. Fine tune and adjust irrigation system weekly coinciding with the landscape and/or turf planting maintenance period.

B. Adjust settings of controllers within WELO water budget and with seasonal changes.

C. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.

D. Adjust sprinklers so they will be flush with, or not more than 1/2 inch above, finish grade.

E. Fill irrigation trenches due to settling.
3.19 CLEANING

A. Completely flush dirt and debris from piping before installing sprinklers and other devices.

B. After completion, cleanup and remove all resultant debris from site.

3.20 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controller and automatic control valves. Refer to Division 1 Section "Demonstration and Training."

3.21 GUARANTEE (Project Close-out Item)

A. Furnish a written Guarantee to the Owner, dated from the date of Final Acceptance, against defective workmanship, materials or components and guaranteeing repair or replacement for a period of 1 year; further guarantee restoration of all damage caused by leaks in the Irrigation System for a like period.

B. Guarantee that the entire installation was made in accordance with the drawings, specifications and manufacturer's recommendations, using designated materials and installation procedures.

C. Submit duplicate copies of the Guarantee for approval by the Owner's Representative. Approval is mandatory before final payment and acceptance.

D. The guarantee for the irrigation system shall be made in accordance with the form attached at the end of this Section. The guarantee form shall be retyped onto the Contractors letterhead and contain the information shown.
GUARANTEE FOR SPRINKLER IRRIGATION SYSTEM

We hereby guarantee that the sprinkler system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the drawings and specifications, ordinary wear and tear and unusual abuse or neglect excepted.

We agree to repair or replace any defects in materials and workmanship which may develop during the period for one (1) year from the date of acceptance and also to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the Owner. We shall make such repairs or replacements within a reasonable time, as determined by the Owner, after receipt of written notice.

The Owner reserves the right to make temporary repairs as necessary to keep the irrigation system and equipment in operating conditions. This shall not relieve the Contractor of his responsibilities under this Guarantee.

In the event of failure to make such repairs or replacements within a reasonable time after receipt of written notice from the Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense and we will pay the costs and charges therefore upon demand.

Project: __________________________________________

Location: _________________________________________

_________________________________________________

Name of Contractor: __________________________________________

Signed:

(AuthorizedSignature) _______________________________________

Print Name of Authorized Signature _______________________________________

Address: _________________________________________________

_________________________________________________

Phone: _________________________________________________

Date of Acceptance: _______________________________________

END OF SECTION
SECTION 32 90 00

PLANTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Trees.
   2. Shrubs.
   3. Ground cover.
   5. Edgings.
   6. Planters.

B. Related Sections include the following:
   1. Specification Section 01 56 39 “Temporary Tree and Plant Protection”.
   2. Specification Section 31 05 13 “Earthwork” for excavation, filling and rough grading and for subsurface aggregate drainange and drainage backfill materials.
   3. Specification Section 32 84 00 “Planting Irrigation”.

1.3 DEFINITIONS

A. 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 kind, type, and size of exterior plant required.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Import Topsoil: Shall be obtained from a local source and coming from a site with similar soil characteristics as the project site. Topsoil shall be fertile, friable, natural loam surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter and free of roots, stumps, stones and rocks and other extraneous or toxic matter harmful to plant growth.

D. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil and be approved to sustain plant life by an approved soil and plant lab.

E. On-site Topsoil: Naturally occurring, on-site, surface soil, usually occurring in the top four (4) to twelve (12) inches of original, undisturbed surface soil containing organic material,
micro-organisms, necessary nutrients and minerals to sustain plant growth and be approved to sustain plant life by an approved soil and plant lab.

F. Planting Soil: On-site topsoil, import topsoil or manufactured topsoil.

G. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

H. Plant material: Exterior plants contained within the planting plan legend in categories of Trees, Shrubs, Vines, Perennials, Annuals and/or Ground Covers.

I. Substantial completion for landscape and irrigation: Work shall be considered substantially complete when irrigation, planting, turf planting and seeding are installed correctly per plans and specifications with only minor adjustments required and approval has been submitted in writing by Owner's Representative.

J. Final completion for landscape and irrigation: Work shall be considered complete when irrigation, planting, turf planting and seeding are installed correctly per plans and specifications and the maintenance period has been completed per plans and specifications and approval has been submitted in writing by Owner's Representative.

1.4 SUBMITTALS

A. Product, Material Data and/or Samples: For each type of product specified. Submit manufacturer's technical data and installation instructions for landscape products conforming to requirements of Section 01 33 00 Submittal Procedures to include, but not be limited to:

1. Samples for the following:
   a. Bark mulch top dressing (1/2 c.f. each)
   b. Edging materials and accessories, of manufacturer's standard size, to verify color selected.

2. Manufacturer's certified analysis for standard products.

3. Material Test Reports: For on-site topsoil, import topsoil and/or manufactured soil proposed for use on this project.

4. Planting soil amendments as recommended by Waypoint Analytical California, Inc.

5. Qualification Data: For landscape Installer in compliance with “Quality Assurance”.

B. Plant Materials List: Submit confirmation from supplier 30 days prior to planting that all plant material has been ordered.

C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer shall be delivered to Owner's Representative upon delivery.

D. Qualification Data: For landscape Installer prior to performing work.

E. Planting Schedule: Indicating anticipated planting dates for each type of planting.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Experience: The landscape installation firm shall have contracted for and successfully completed construction of a minimum of five (5) California public school district
construction projects, approved by the Division of the State Architect (DSA), within the past five (5) years of similar size, complexity, budget and scope.

2. Licensure: The landscape installation firm shall hold a current, active C27 “Landscaping Contractor” license classification by the California State License Board that has been consistently active for at least five (5) years and that has not been suspended or revoked.

3. Supervision: The landscape installation firm shall have a qualified and experienced landscape technician on site during landscape installation.

B. Soil-Testing Laboratory Qualifications: Testing lab shall be Waypoint Analytical California, Inc. located in San Jose (408) 727-0330 or Anaheim (714) 282-8777, or approved equal 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.

C. Soil 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 (CEC) or total exchangeable cations (TEC); sodium absorption ratio; deleterious material; pH; soluable salts, boron, mineral and plant-nutrient content of planting soil.

1. Report suitability of planting soil for plant growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory planting soil.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section “Project Management and Coordination” with General Contractor and/or Owner’s Representative.

E. Protect existing to remain and newly installed lawn and/or landscape areas from damage or trespass by maintaining construction fencing during construction and maintenance.

F. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, “American Standard for Nursery Stock.”

1. Selection of exterior plants purchased under allowances will be made by Owner’s Representative, who will tag plants at their place of growth before they are prepared for transplanting.

G. 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 above ground for trees up to 4-inch caliper size, and 12 inches above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

H. Observation: Owner’s Representative may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Owner’s Representative retains right to observe trees and shrubs further 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 work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Owner’s Representative of sources of planting materials 30 days in advance of delivery to site.
I. Protect all planting areas from trespass or damage by installing temporary barriers or protective fencing during construction. Barrier and/or fencing material and installation method shall be approved by Owner’s Representative prior to installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Notify Owner’s Representative fourteen (14) days prior to anticipated plant material delivery to schedule review of plant material prior to installation.

B. Do not prune trees and shrubs before delivery, except as approved by Owner’s Representative. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.

C. Handle planting stock by root ball.

D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants in shade, protect from weather and mechanical damage, and keep roots moist.
   1. Do not remove container-grown stock from containers before time of planting.
   2. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 PROJECT/SITE CONDITIONS

A. Prior to placing topsoil, Contractor shall collect and submit soil samples representative of on-site topsoil and/or import topsoil proposed for use in all planting and lawn areas to a Soil-Testing Laboratory for analysis and soil amending recommendations. Submit test results analysis and recommendations to Owner’s Representative for review and approval prior to beginning work.

B. Weather Limitations: Proceed with planting only when weather conditions permit.

C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns, unless otherwise acceptable to Owner’s Representative.
   1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

D. Contractor shall protect new plantings and/or delay planting in event of forecasted freezing temperatures.

1.8 WARRANTY

A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner or users, or incidents that are beyond Contractor’s control.
   1. Warranty Period for Trees, Shrubs, Vines, Lawns and Ground Covers: One year from date of Final Completion.
   2. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
3. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

4. A limit of one replacement of each exterior plant will be required, except for losses or replacements due to failure to comply with requirements.

1.9 MAINTENANCE

A. Plant Material and Planting Areas: Maintain for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting basins, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Refer to “Maintenance Schedule.”

1. Maintenance Period: Ninety (90) days from date of Owners Representative’s written approval of Substantial Completion of the planting and irrigation.

PART 2 - PRODUCTS

2.1 TREE, SHRUB AND VINE MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Owner’s Representative, with a proportionate increase in size of roots or balls.

C. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

D. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

E. Provide plant material as specified on the Drawings including size, genus, species and variety.

2.2 SINGLE-TRUNK AND MULTI-TRUNK TREES

A. Trees: Single-trunk or multi-trunk trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

1. Branching Height: typical of tree species and container size, single trunk unless specified as multi-trunk on Planting Plan Legend. Select branching height in accordance with planting location. Low branching trees shall not be planted in conflict with pathways, driveways and/or structures.

2. Single-stem trees shall have straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

3. Multi-stem trees shall branch naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1.
2.3 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.4 PLANTS

A. Annuals: Provide healthy, disease-free plants of species and variety shown or listed. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud and bloom.

B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, remove dead flowers.

2.5 TOPSOIL

A. Prior to placing bid, Contractor to coordinate with General Contractor, Demolition and/or Grading Contractors and verify quantity and source of planting soil for all planting areas. Identify Contractor responsible for stockpiling on-site topsoil and/or acquiring import planting soil and installing a minimum of twelve (12) inches of planting soil in all landscape planting areas and any raised planters and rough grading in accordance with these specifications, details, notes, grading and drainage plans.

B. Coordinate with General Contractor, Demolition and/or Grading Contractors for removal and replacement of lime treated soils and replacement with planting soil prior to planting to depth required to remove lime treatment.

C. On-site topsoil: Re-use existing topsoil or existing surface soil, top twelve (12) inches excavated and stockpiled on-site. Verify suitability of existing and/or stockpiled surface soil to produce planting soil by submitting a sample to a soil testing laboratory. Acceptable on-site topsoil shall be ASTM D 5268, pH range of 6.0 to 7.0, representative of productive soils in the vicinity, a range of 4 to 20 percent organic material content; free of stones one (1) inch or larger in any dimension, roots, plants, sod, clay lumps and other extraneous materials harmful to plant growth. Sodium absorption rate (SAR) shall not exceed 5.0, conductivity of the saturation extract solution shall not exceed 3.0, and boron concentration in the saturation shall not exceed 1.0 ppm.

D. Import Topsoil: Supplement with imported or manufactured topsoil from off-site, local sources, when quantities of on-site topsoil are insufficient. Do not obtain topsoil from bogs or marshes. If soil is obtained from agricultural land, Contractor shall submit proof soil is nematode free. Import topsoil shall meet the following requirements:

1. USDA Classification of fraction passing 2.0 mm sieve: sandy loam, sandy clay loam or loam.

2. Class | Particle size range | maximum, % | minimum, %
---|---|---|---
Coarse Sand | 0.5 – 2.0 mm | 15 | 0
Silt .002-.05 mm | 30 | 10
Clay | <.002 mm | 25 | 10

Other Classes
Gravel | 2-13 mm | 15 | 0
Rock | ¼-1 inch | 5% by volume with none >1 inch
3. Chemistry – Suitability Considerations

Salinity: Saturation Extract Conductivity (ECe)
   Less than 3.0 dS/m @ 25 degrees C.
Sodium: Sodium Adsorption Ratio (SAR)
   Less than 1.00 ppm
Boron: Saturation Extract Concentration
   Less than 6

Reaction: pH of Saturated Paste: 5.5 – 7.5 without high lime content.

4. Soil to contain sufficient quantities of available nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant growth. In the event of nutrient inadequacies, provisions shall be made to add required materials prior to planting.

5. Soil testing: Contractor shall submit to the Owner's representative for approval, certification from an agricultural soils testing laboratory that the import topsoil provided conforms to the specifications prior to delivery of import or placement on on-site topsoil. Soil testing shall have been performed on import topsoil source within the previous year.

2.6 BIO-RETENTION BASIN

A. Refer to civil drawings for construction of bio-retention basin swales.

B. Line bio-retention basin swale with Lenox Blend soil mixture available from LH Voss Materials, Inc. 2445 Del Vista Monte, Concord, CA 94520, www.lhvoss.com, (800) 660-8677, Rob Hawkins x 108, Butch Voss x 109. Depth shall be a minimum of 18” unless specified otherwise within plans and/or details.

2.7 FERTILIZER AND SOIL AMENDMENTS

A. Contractor shall collect and submit sample of proposed planting soil, representative of the top eight (8) inches of planting soil, to a locally known soil testing laboratory, Waypoint Analytical California, Inc. (408) 727-0330, or approved equal, for analysis and amendment recommendations. Sample shall be representative of typical on-site topsoil proposed for use in planting areas.

B. If import topsoil is proposed, import topsoil sample shall be submitted to a locally known soil testing laboratory, Waypoint Analytical California, Inc., or approved equal, for analysis, amendment recommendations and installation recommendations.

C. Contractor shall provide Waypoint Analytical California, Inc., or approved equal, the following information when submitting soil for analysis:
   1. Project type (public school, commercial building, etc.).
   2. Anticipated maintenance (regular, low, none, etc.).
   3. Irrigation water source (potable or recycled).
   4. Proposed plant material type such as California native plants, turf, shrub and ground covers.
   5. Copy of this specification.
D. Fertilizers: All fertilizers shall be of an approved brand with a guaranteed chemical analysis as required by USDA regulations and shall be dry and (except for plant tabs) free flowing.

E. Soil Conditioner: 0-1/4 inch nitrogen-fortified organic amendment contributing at least 270 pounds of organic matter per cubic yard. Greenwaste compost is acceptable if recommended by Waypoint Analytical California, Inc., or approved equal. Compost shall be obtained from a supplier participating in the Seal of Testing Assurance (STA) program of the U.S. Composting Council.

F. Planting Tablets: 21 gram controlled release fertilizer supplying nitrogen for up to 1 1/2 years and 20-10-5 content.

G. Backfill Mix: Shall be a mixture of on-site or import topsoil, soil conditioner and fertilizer. For bidding purposes, backfill mix shall include 2/3 topsoil and 1/3 soil conditioner with 6-20-20 granular fertilizer, quantity per manufacturer, according to container or root stock size, mixed thoroughly.

2.8 MULCHES

A. Organic Mulch for non-bio-retention planting areas: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of organic bark from Republic Services (contact Glenn Bohling at (408) 687-1928 or GBohling@RepublicServices.com) Pro-Chip decorative mulch, Browning Ferris Industries, Newby Island Recyclery, Milpitas, CA. Color to be mahogany. Submit sample to Owners Representative's for review and approval.

B. Organic Mulch for Bio-retention basin swales: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of organic shredded cedar bark from Sun Gro Horticulture (800) 222-2551, or equal. Submit sample to Owners Representative’s for review and approval.

2.9 HERBICIDES

A. Pre-emergent: Ronstar-G, or approved equal.

B. Selective and non-selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

C. Contact Owner and obtain School District, Local, State and Federal policies and procedures for regulating application of chemical controls. Contractor shall comply with all applicable policies and/or procedures for application, posting and notifications.

2.10 STAKES AND GUYS

A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, redwood, or pressure-preservative-treated Douglas Fir or Lodgepole Pine, free of knots, holes, cross grain, and other defects, two (2) inches in diameter by length required, and pointed at one end.

B. Guy and Tie Wire: ASTM A 641/A 641M, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 inch in diameter.

C. Guy Cable: 5-strand, 3/16-inch- diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
D. Tree Ties: Z-Strap tree ties, or equal, made of one (1) inch wide black rubber with pre-punched nail holes, a tensile strength of 400 psi, a breaking strength of 75 pounds per inch of width and resistant to ozone deterioration. Contact Sullivan & Mann Lumber Company, Inc. (800) 847-6562.

E. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

2.11 LANDSCAPE EDGINGS/HEADERBOARD

A. Of sizes shown, and as follows:
   1. Species: Construction Heart Redwood.
   2. Stakes: Construction heart redwood, 1 by 2 by 16 inches long in nominal size, with galvanized nails for anchoring edging.
   3. Splice Plate: Same species as edging, 1 by 6 by 24 inches long in nominal size, with galvanized nails for securing in place.

2.12 WATER

A. Water shall be suitable for irrigation and free from ingredients harmful to planting areas.

2.13 MISCELLANEOUS PRODUCTS

A. Tree Trunk Guard: nine (9) inch high by four (4) inch diameter plastic, corrugated tube, Arbor Guard + or equal.

B. Tree Root Barriers: 18" high by 24" wide, interlocking panels of not less than 0.080" (2.032 mm) thickness, black in color, at least 50% recycled material, injection molded plastic product for linear applications with ultra-violet inhibitors with anti-lift ground lock tabs, vertical root deflecting ribs and double top edge consisting of two parallel, horizontal ribs on the top.

C. Jute Netting: Biodegradable in two (2) to three (3) years from installation, absorbing water four to five times fabric weight, open area 60% to 65%, available in rolls four (4) feet in width. Use galvanized steel staples as recommended by manufacturer to secure netting in place.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Planting operations shall be performed when weather and soil conditions are suitable for planting.

3.2 PREPARATION

A. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

B. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.
C. Install protective barriers and/or fencing as necessary.

D. Contact and obtain Owner’s Representative, Local, State and Federal policies and procedures for regulating application of fertilizers, fungicides, insecticides, pesticides and herbicides. Contractor shall comply with all applicable policies and/or procedures for application, posting and notifications.

E. Do not excavate, place soils or amend soils during wet or saturated conditions.

F. If lime treated soils have not been removed from proposed planting areas, remove and replace with acceptable topsoil.

G. Verify depth of planting soil in proposed planting areas. If depth of planting soil is less than twelve (12) inches in depth, install additional planting soil to ensure twelve (12) inch minimum depth of topsoil.

H. Import topsoil Installation:
   1. Remove and disposed of stones larger than one (1) inch in any dimension, vegetation and foreign inorganic material from surface to receive import topsoil.
   2. Scarify or plow the subgrade by crossripping or equivalent to a minimum depth of four (4) inches until it is loose and uncompacted to provide bonding of imported planting soil layer to subgrade.
   3. Place planting soil on loosened material in four (4) inch layers. Crossrip first import planting soil layer to a depth of eight (8) inches and blend import planting soil with loose native surface soil. Roll lightly with appropriate lawn roller to consolidate soil and compact to 85% density.
   4. Continue placement of planting soil after blending first layer with native soil in four (4) inch layers and rolling lightly to consolidate and compact each layer of soil and compact to 85% density.
   5. Place topsoil to the lines and grades in accordance with grading Drawings.

3.3 SOIL AMENDING AND FINE GRADING (Amend per Soil-Testing Laboratory recommendations. The following amendment recommendations are given for bidding purposes only.) Contractor shall prepare and amend soil over entire planting areas and as recommended for backfill at individual planting pits.

A. Soil Preparation: Loosen subgrade of planting beds by crossripping or equivalent cultivation to a minimum depth of ten (10) inches. Remove stones larger than one (1) inch in any dimension and sticks, roots, rubbish, and other extraneous matter in the top six (6) inches of soil and legally dispose of them off Owner’s property.

B. Soil Amending: (Amend per Soil-Testing Laboratory recommendations. The following recommendations are provided for bidding purposes only. Contractor shall amend soil for over-all preparation and amendment recommendations and for planting pit preparation, amendments and backfill) Add the following and thoroughly till into the top eight (8) inches of planting soil at the following rates per 1,000 square feet. Till planting soil to a homogeneous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter. Float, rake and roll all planter areas to establish finished grades, maintaining drainage patterns and swales for grading and drainage plans, creating smooth, uniform surface plane.
   1. 6 cubic yards nitrogen fortified organic soil amendment.
a. In order to comply with MWELO 492.6, 3. (C). Soil Preparation, Mulch and Amendments, at a minimum, compost shall be applied at a rate of four (4) cubic yards per 1,000 square feet of permeable area incorporated to a depth of six (6) inches into the soil. Soils with greater than 6% of organic matter in the top six (6) inches are exempt from adding compost.

2. 14 pounds all-purpose granular fertilizer (6-20-20).

3. 15 pounds soil sulfur.

4. Soil conditioner: three cubic yards per 1,000 SF sufficient for 3% to 5% soil organic matter on a dry weight basis.

C. Fine Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Refer to civil grading plans and conform to designed grades, drainage patterns, swales, and ridges. There shall be no areas that hold water or drain toward buildings or structures, unless designed per civil grading plans.

In planting areas, set finish grade of soil one and one half (1 1/2) inches below adjacent paved surfaces, utility boxes, tops of curbs, and the like to allow for installation of bark mulch top dressing above.

Regrade as necessary to restore grades and drainage patterns after installation of plant material.

3.4 BIO-RETENTION SOIL AND INSTALLATION

A. Preparation:

1. Prior to installation of bio-retention soil, protect native soil at excavated bio-retention area from compaction by preventing traffic and installing a fence or covering with plywood.

2. Protect bio-retention soil stockpile from compaction and contamination from foreign matter by covering with a protective tarp.

3. Verify installation of subsurface and surface drainage with Civil Engineer prior to placing bio-retention soil.

4. Drainage should be directed away from bio-retention soils until upslope areas are stabilized and compacted.

B. Bio-Retention Soil Mixing and Placing:

1. Operate equipment adjacent to bio-retention area and not in bio-retention area to avoid compaction.

2. If machinery must operate in the bio-retention area or adjacent planting area, use light weight, low ground-contact pressure equipment.

3. Where bio-retention soil meets native soil, rip or scarify the bottom native soils of the bio-retention area to a depth of four (4) inches.

4. If mixing bio-retention soil and amendments on-site, use an adjacent impervious area or plastic sheeting to prevent intrusion of foreign material.

5. Place bio-retention soil in 12” lifts. Do not place or work bio-retention soil if it is saturated or raining.
6. Allow bio-retention soil lifts to settle naturally, boot pack (walk around to compact) lifts to achieve 85% compaction or compact by lightly watering until soils are just saturated and allow bio-retention soils to dry between lifts.

7. Verify bio-retention soil elevations comply with grading design prior to applying mulch or installing plants.

8. After all lifts are placed, wait three (3) days to check for settlement, and add additional bio-retention soil as needed.

3.5 EDGING/HEADERBOARD INSTALLATION

A. Redwood Headerboard: Install wood headers or edgings where indicated. Anchor with wood stakes spaced per detail, driven at least 1 inch below top elevation of header or edging. Use 2 galvanized nails per stake to fasten headers and edging; length as needed to penetrate both members and provide 1/2-inch clinch at point. Chamfer top of stakes as indicated on detail and pre-drill stakes if needed to avoid splitting.

3.6 PLANT MATERIAL EXCAVATION

A. Lay out individual tree and shrub locations and areas for multiple exterior plantings. Stake locations, outline areas, adjust locations when requested, and obtain Owner’s Representative’s acceptance of layout before planting. Make minor adjustments as required.

B. Lay out exterior plants at locations directed by Owner’s Representative. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

C. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.

1. Excavate approximately planting pit sizes as indicated on planting details.

2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for root stock.

3. Set rootball onto compacted native soil so that rootball sits one (1) inch above adjacent finish grade.

D. Obstructions: Notify Owner’s Representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

E. Drainage: Notify Owner’s Representative if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

F. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.7 PLANT MATERIAL PLANTING

A. Carefully remove root ball from container without damaging root ball or plant.

B. Set container grown planting stock plumb and in center of pit or trench with top of root ball one (1) inch above adjacent finish grades. Face plant material for best appearance.

C. Place planting soil around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly.
D. Place planting tablets in hole about one (1) to two (2) inches away from root tips. Refer to manufacturer’s recommendation for exact quantity, but not less than:

<table>
<thead>
<tr>
<th>Plant size</th>
<th>Quantity</th>
<th>Plant size</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 gallon container</td>
<td>1</td>
<td>7 gallon container</td>
<td>5</td>
</tr>
<tr>
<td>2 gallon container</td>
<td>2</td>
<td>15 gallon container</td>
<td>8</td>
</tr>
<tr>
<td>3 gallon container</td>
<td>3</td>
<td>24&quot; box container</td>
<td>20</td>
</tr>
<tr>
<td>5 gallon container</td>
<td>3</td>
<td>36&quot; box container</td>
<td>30</td>
</tr>
</tbody>
</table>

E. Finish placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil.

3.8 TREE AND SHRUB PRUNING

A. Prune, thin, and shape trees and shrubs as directed by Owner’s Representative.

B. Trees:
   1. Prune, thin, and shape trees according to standard horticultural practices.
   2. Prune trees if necessary to remove lower branches for clearance above pedestrian or vehicular pathways.
   3. Unless otherwise indicated by Owner’s Representative, do not cut tree leaders.
   4. Prune trees as required to properly stake trees straight and plumb without branches rubbing stakes.
   5. Prune to thin a heavy canopy and prune for a strong branching structure as appropriate to individual tree species.
   6. Prune to remove injured or dead branches from trees.

C. Shrubs, Vines and Ground Covers:
   1. Prune, thin and shape shrubs according to standard horticultural practices.
   2. Prune to remove injured or dead branches from shrubs.

3.9 GUUYING AND STAKING

A. Upright Staking and Tying: Unless detailed otherwise, use a minimum of 2 stakes of length required to penetrate at least six (6) inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses. Brace tree stakes with wood horizontal bracing screwed in place. Support trees with two rubber tree tie sections at contact points with the tree trunk installed in a “figure 8” wrap. Allow enough slack to avoid rigid restraint of tree. Trim stakes below tree canopy and to matching heights. Use the number of stakes as follows:
   1. Use 2 stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper.
   2. Use 3 stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
   3. Use 3 stakes for tree all sizes if detailed on Drawings.

B. Guying and Staking: Guy and stake trees exceeding 14 feet in height and more than 3 inches in caliper, unless otherwise indicated. Securely attach no fewer than 3 guys to stakes 30 inches long, driven to grade.
1. For trees more than 6 inches in caliper, anchor guys to pressure-preservative-treated deadmen 8 inches in diameter and 48 inches long buried at least 36 inches below grade. Provide turnbuckles for each guy wire and tighten securely.

2. Attach flags to each guy wire, 30 inches above finish grade.

3. Paint turnbuckles with luminescent white paint.

3.10 TREE ROOT BARRIERS

A. Install root barriers where trees are planted within six (6) feet of any pavement or structures.

B. A linear root barrier shall be installed flush with the vertical edge of pavement or structure, one half (1/2) inch below the top of the pavement and shall extend six (6) feet in each direction for a total of twelve (12) feet in length. Contractor shall remove concrete spillage if necessary to install barrier flush against vertical concrete edge.

3.11 TREE TRUNK GUARD: install to protect newly planted tree trunks planted in lawns according to manufacturer recommendations.

3.12 RAISED PLANTERS

A. Fill raised planters with amended planting soil. Place planting soil in twelve (12) inch deep, compacted layers to 85% relative density to an elevation of four (4) inches below the top of the raised planter (unless detailed otherwise on Drawings).

3.13 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants spaced as indicated on planting legend.

B. Dig holes large enough to allow spreading of roots, and backfill with planting soil.

C. Work planting soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.14 PRE-EMERGENT

A. Apply pre-emergent herbicide per manufacturer recommendations in new planting areas.

3.15 JUTE NETTING

A. Install jute netting on slopes exceeding 3:1 ratio slope. Apply jute netting after preparing planting soil for planting and fine grading. Secure jute netting starting at the top of the slope by laying six (6) inches of fabric below grade to a minimum depth of six (6) inches. Roll jute netting down slope and terminate where grade becomes level by folding six (6) inches of fabric underneath. Overlap seems four (4) to six (6) inches. Secure in place using staples placed eighteen (18) inches on center spacing. After completion of planting operations, install top dressing/mulch as specified herein.

3.16 PLANTING BED MULCHING
A. Apply three (3) inch minimum thickness of organic mulch, unless specified otherwise on Drawings, continuously throughout planting areas. Do not place mulch within two (2) inches of stems and six (6) inches of tree trunks.

3.17 CLEANUP AND PROTECTION

A. During exterior planting, keep adjacent pavings and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation, repair, or replace damaged exterior planting.

C. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

3.18 MAINTENANCE SCHEDULE

A. Protection: Protect work from damage, erosion and trespass. Maintain temporary fencing and/or barriers in proper condition. Remove temporary fencing and/or barriers prior to final completion and at end of maintenance period.

B. After substantial completion, Contractor shall schedule an Irrigation Audit to be performed by a third party certified landscape irrigation auditor. Contractor shall make necessary adjustments, if any, during maintenance period and provide written certification of installation from certified landscape irrigation auditor as part of final completion and end of maintenance.

C. Water: Contractor shall be solely responsible for ensuring that all planting is sufficiently watered to promote vigorous growth. Test and inspect irrigation system on a regular basis, each week during plant establishment and monthly thereafter. Adjust and repair the irrigation system and its components as necessary for plant establishment and growth and for watering efficiency. Check and adjust any obstructions to emission devices.

D. Fertilizing (confirm with Waypoint Analytical California, Inc., or approved equal, recommendations): Immediately after completion of planting, fertilize landscape areas with ammonium sulfate (21-0-0) fertilizer at a rate of five (5) pounds per 1000 square feet. Fertilize with specified fertilizer after 45 days, prior to end of maintenance period. After landscape becomes well-established, fertilize in fall and spring with (16-6-8) commercial fertilizer at a rate of six (6) pounds per 1000 square feet.

E. Weed Control: Maintain planting beds (planted or not) in a weed-free condition to be performed weekly during maintenance period. Weeding may be done manually or by the use of selective herbicides. (Contractor shall obtain written approval from project owner prior to application of herbicide) No herbicide shall be used without the Owner Representative’s prior consent. Use only approved herbicides, use in accordance with manufacturer’s recommendations and per Pest Control Advisor’s recommendations. If selective herbicides are used, extreme caution shall be observed so as not to damage any other plants. Spraying shall be done only under windless conditions.

F. Disease, Pest and Insect Control: Disease, pest (including, but not limited to, birds and rodents) and insect damage shall be controlled by the use of fungicides, insecticides pesticides, poisons and/or mechanical means. (Contractor shall obtain written approval
from project owner prior to application of fungicides, insecticides or pesticides or mechanical methods). Review and perform weekly during maintenance period.

G. Plant Material: Maintain trees, shrubs and other plants by pruning, cultivating and weeding as required for healthy growth. Restore planting pits as necessary. Tighten and repair stake supports and reset trees and shrubs to proper grades or vertical position as required. Review and perform weekly during maintenance period.

H. Bark Mulch: Re-apply bark mulch top dressing after initial settling and again prior to end of maintenance to ensure specified depth is achieved.

I. End of maintenance shall be reviewed and approved in writing by Owner's Representative. Upon approval, Contractor shall notify Owner's Representative in writing when maintenance is complete with a date which maintenance transfers to Owner.

3.19 FIELD QUALITY CONTROL, SUBSTANTIAL COMPLETION AND FINAL COMPLETION

A. Owner's Representative shall inspect and approve the following prior to proceeding with subsequent work:
   1. Preparation: at completion of finish grading and prior to planting, grading tolerances and soil preparation shall be checked for conformance to Drawings and as specified herein.
   2. Layout: Layout of all plants, headerboard and other major elements shall be directed and/or approved by Owner's Representative.
   3. Substantial Completion Review: At substantial completion of this Section, work shall be reviewed for conformance with the Drawings and Contractor shall make recommended repairs and/or corrections in a timely manner.
   4. Final Completion Review: After substantial completion repairs and/or corrections have been completed, work shall be reviewed for final completion and approved by Owner's Representative in writing.

B. Re-inspections required due to Contractor not being prepared or non-conformance to Drawings shall be back charged to the Contractor.

C. Contractor shall remove protective fencing and/or barriers prior to final completion review.

END OF SECTION 32 90 00
SECTION 32 92 00
TURF PLANTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Sodding.

B. Related Sections include the following:
   1. Specification Section 31 10 00 "Site Clearing" for topsoil stripping and stockpiling.
   2. Specification Section 31 05 13 "Earthwork" for excavation, filling and backfilling, and rough grading.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Import Topsoil: Shall be obtained from a local source and coming from a site with similar soil characteristics as the project site. Topsoil shall be fertile, friable, natural loam surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter and free of roots, stumps, stones and rocks and other extraneous or toxic matter harmful to plant growth.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending nutrients, minerals, soils or sand with stabilized organic soil amendments to produce surface planting soil capable of sustaining plant growth.

D. Planting Soil: On-site topsoil, import topsoil or manufactured topsoil.

E. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath topsoil.

F. On-site Topsoil: Naturally occurring, on-site, surface soil, usually occurring in the top four (4) to twelve (12) inches of original, undisturbed surface soil containing organic material, necessary nutrients and minerals to sustain plant growth and be approved to sustain plant life by an approved soil and plant lab.

G. Substantial completion for landscape and irrigation: Work shall be considered substantially complete when irrigation, planting, turf planting and seeding are installed
correctly per plans and specifications with only minor adjustments required and approval has been submitted in writing by Owner's Representative.

H. Final completion for landscape and irrigation: Work shall be considered complete when irrigation, planting, turf planting and seeding are installed correctly per plans and specifications and the maintenance period has been completed per plans and specifications and approval has been submitted in writing by Owner's Representative.

1.4 SUBMITTALS

A. Product and Material Data: For each type of product specified, Submit manufacturer's technical data and installation instructions for landscape products conforming to requirements of Section 01 33 00 Submittal Procedures to include, but not be limited to:

1. Analysis of proposed soil amending materials by Waypoint Analytical California, Inc. (408) 727-0330, or approved equal, made according to methods established by the Association of Official Analytical Chemists, where applicable.

2. Samples for Verification: For each of the following:
   a. Soil conditioner (1/2 c.f. each).

3. Certification of turfgrass sod, identifying source, including name and telephone number of supplier.

4. Material Test Reports: For on-site topsoil, import topsoil and/or manufactured soil proposed for use on this project.

5. Planting soil amendments as recommended by Waypoint Analytical California, Inc. (408) 727-0330, or approved equal.

B. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer shall be delivered to Owner's Representative upon delivery.

C. Qualification Data: For landscape Installer prior to performing work.

D. Planting Schedule: Indicating anticipated planting dates for turf installation.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Experience: The turf installation firm shall have contracted for and successfully completed construction of a minimum of five (5) California public school district construction projects, approved by the Division of the State Architect (DSA), within the past five (5) years of similar size, complexity, budget and scope.

2. Licensure: The turf installation firm shall hold a current, active C27 "Landscaping Contractor" license classification by the California State License Board that has been consistently active for at least five (5) years and that has not been suspended or revoked.

3. Supervision: The turf installation firm shall have a qualified and experienced turf technician on site during turf installation.
B. Soil-Testing Laboratory Qualifications: Testing lab shall be Waypoint Analytical California, Inc., located in San Jose (408) 727-0330 or Anaheim (714) 282-8777, or approved equal 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.

C. Soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory, Waypoint Analytical California, Inc. (408) 727-0330, or approved equal, stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity (CEC) or total exchangeable cations (TEC); sodium absorption ratio; deleterious material; pH; soluble salts, boron, mineral and plant-nutrient content of planting soil.

1. Report suitability of planting soil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory planting soil.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section “Project Management and Coordination.”

E. Protect all lawn areas from damage or trespass by maintaining construction fencing during construction and maintenance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Sod: Harvest, deliver, store, and handle sod according to requirements in Turf Producers International's (TPI) "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

1.7 SCHEDULING

A. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Sodded Lawns: Maintenance period shall be a minimum of ninety (90) days from date of Owner’s Representative written approval of Substantial Completion and when there are no visible joints, roots are thoroughly knit to the soil and sod appears to be uniformly healthy and green in color.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and spraying for insects and disease and other operations. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth lawn. Implement pest management as necessary to controls pests, including gophers.
1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and/or maintain temporary piping, hoses, and lawn-watering equipment as necessary to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of mulch.

2. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one third (1/3) of grass height. Remove no more than one third (1/3) of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

   1. Mow and edge before turf reaches three and one-quarter (3-1/4) inches high.

   2. Cut to two and one-half (2-1/2) inches high.

   3. Remove all clippings.

E. Lawn Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.

   1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

F. Maintain protective barriers in place, erect and secure and clear of lawn edges to allow for uniform growth and for trimming and so as not to block irrigation spray pattern.

1.9 WARRANTY

A. All work executed under this Section shall be warranted free of defects and poor workmanship for a period of one (1) year after date of Final Completion.

B. Turf planting shall be warranted to be in healthy and thriving condition during Warranty period, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Contractor’s control.

C. Repair and/or re-sod turf areas not in vigorous condition immediately upon notification by Owner’s Representative during Warranty period.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable
sod of uniform density, color, and texture, strongly rooted, and capable of vigorous
growth and development when planted. Not less than 2 years old, free of weeds and
undesirable native grasses and machine cut rolls to pad thickness of 5/8 inch, rolled, 4'
wide and 90' length.

B. Turfgrass Species: Sod of grass species as follows, with not less than 90 percent
germination, not less than 95 percent pure seed, and free of weed seed:
a. 90-10 Tall Fescue blend.

C. Delivery, Storage and Handling: Sod shall be harvested, delivered and installed within
a period of 24 hours. Sod shall be kept moist, fresh and protected at all times.

2.2 PLANTING SOIL

A. Prior to placing bid, Contractor to coordinate with General Contractor, Demolition
and/or Grading Contractors and verify quantity and source of planting soil for turf
planting areas. Identify Contractor responsible for stockpiling on-site topsoil and/or
acquiring import planting soil and installing a minimum of twelve (12) inches of planting
soil in turf planting areas and rough grading in accordance with these specifications,
details, notes, grading and drainage plans.

B. Coordinate with General Contractor, Demolition and/or Grading Contractors for removal
and replacement of any lime treated soils and replacement with planting soil prior to
planting turf to depth required to remove lime treatment.

C. On-site topsoil: Reuse existing topsoil or existing surface soil, found in the top twelve
(12) inches, excavated and stockpiled on-site. Verify suitability of existing and/or
stockpiled surface soil to produce planting soil by submitting a sample to Waypoint
Analytical California, Inc. (408) 727-0330, or approved equal. Acceptable on-site
topsoil shall be ASTM D 5268, pH range of 6.0 to 7.0, representative of productive soils
in the vicinity, a range of 4 to 20 percent organic material content; free of stones one
(1) inch or larger in any dimension, roots, plants, sod, clay lumps and other extraneous
materials harmful to plant growth. Sodium absorption rate (SAR) shall not exceed 5.0,
conductivity of the saturation extract solution shall not exceed 3.0, and boron
concentration in the saturation shall not exceed 1.0 ppm.

D. Import Topsoil: Supplement with imported or manufactured topsoil from off-site,
local sources, when quantities of on-site topsoil are insufficient. Do not obtain topsoil
from bogs or marshes. If soil is obtained from agricultural land, Contractor shall
submit proof soil is nematode free. Import topsoil shall meet the following
requirements:
1. USDA Classification of fraction passing 2.0 mm sieve: sandy loam, sandy clay
loam or loam.

2. Class       Particle size range maximum, %  minimum, %
Coarse Sand  0.5 – 2.0 mm  15            0
Silt .002-.05 mm  30       10
Clay       <.002 mm  25            10
Other Classes
Gravel  2-13 mm  15   0
Rock    ½-1 inch  5% by volume with none >1 inch
Organic 15   0

3. Chemistry – Suitability Considerations
Salinity: Saturation Extract Conductivity (ECe)
   Less than 3.0 dS/m @ 25 degrees C.
Sodium: Sodium Adsorption Ratio (SAR)
   Less than 1.00 ppm
Boron: Saturation Extract Concentration
   Less than 6

   Reaction: pH of Saturated Paste: 5.5 – 7.5 without high lime content.

4. Soil to contain sufficient quantities of available nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant growth. In the event of nutrient inadequacies, provisions shall be made to add required materials prior to planting.

5. Soil testing: Contractor shall submit to the Owner's representative for approval, certification from an agricultural soils testing laboratory, Waypoint Analytical California, Inc. (408) 727-0330, or approved equal, that the import topsoil provided conforms to the specifications prior to delivery of import or placement of on-site topsoil. Soil testing shall have been performed on import topsoil source within the previous year.

2.3 FERTILIZER AND SOIL AMENDMENTS
A. Contractor shall collect and submit two samples of proposed planting soil, representative of the top six (6) inches of planting soil, to a locally known soil testing laboratory, Waypoint Analytical California, Inc. (408) 727-0330, or approved equal, for analysis and amendment recommendations. Soil samples shall be taken from proposed planting areas or topsoil source. Sample shall be taken to a depth of 8 inches. Contractor shall amend per soil testing laboratory recommendations. Soil amendments in this specification are provided for bidding purposes only.

B. Fertilizers: All fertilizers shall be of an approved brand with a guaranteed chemical analysis as required by USDA regulations and shall be dry and (except for plant tabs) free flowing.

C. Soil Preparation: As specified in soil laboratory recommendation. The following materials and quantities are given for bidding purposes only. Contractor shall amend soil using products, quantities and methods specified by Waypoint Analytical California, Inc., or approved equal.
   1. 6-20-20 granular fertilizer.
   2. Soil sulfur.

D. Soil Conditioner: 0-1/4 inch nitrogen-fortified organic amendment contributing at least 270 pounds of organic matter per cubic yard.
E. Planting Tablets: 21 gram controlled release fertilizer supplying nitrogen for up to 1 1/2 years and 20-10-5 content.

2.4 HERBICIDES

A. All herbicides shall be approved by the District prior to use.

B. Contractor shall contact Owner's Representative prior to application of herbicides for District policies, rules and regulations pertaining to herbicide application.

C. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application to remove broad-leaf weeds from existing turf.

D. Non-selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application to remove herbaceous vegetation in areas indicated.

2.5 WATER

A. Water shall be suitable for irrigation and free from ingredients harmful to sodded areas.

2.6 LANDSCAPE EDGINGS/HEADERBOARD

A. Wood Strip Edging: Of sizes shown, and as follows:
   1. Wood Material: Construction heart redwood, 2 by 6 in size, length as required.
   2. Stakes: Construction grade, rough sawn, wood, 2 by 2 by 16 inches long in nominal size, with galvanized, wood, screws for anchoring edging to wood strip edging.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Planting operations shall be performed when weather and soil conditions are suitable for planting.

3.2 PREPARATION

A. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

B. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

C. Install protective barriers and/or fencing as necessary.

D. Contact and obtain Owner's Representative, Local, State and Federal policies and procedures for regulating application of fertilizers, fungicides, insecticides, pesticides
and herbicides. Contractor shall comply with all applicable policies and/or procedures for application, posting and notifications.

E. Import Planting Soil Installation:

1. Remove and dispose of stones larger than one (1) inch in any dimension, vegetation and foreign inorganic material from surface to receive import topsoil.

2. Scarify or plow the subgrade by crossripping or equivalent to a minimum depth of four (4) inches until it is loose and uncompacted to provide bonding of imported topsoil layer to subgrade.

3. Place topsoil on loosened material in six (6) inch layers. Crossrip first import topsoil layer to a depth of eight (8) inches and blend import topsoil with loose native surface soil. Roll lightly with appropriate lawn roller to consolidate topsoil and compact to 85% density.

4. Continue placement of import topsoil after blending first layer with native soil in six (6) inch layers and rolling lightly to consolidate and compact each layer of topsoil.

5. Place topsoil to the lines and grades in accordance with grading Drawings.

F. Verify installation of planting soil to minimum depth of six (6) inches and rough grading completed to proper slopes and elevations.

G. Verify lime treated soils have been removed and replaced with acceptable planting soil.

3.3 SOIL AMENDING AND FINE GRADING (Amend per Soil-Testing Laboratory recommendations. The following recommendations are given for bidding purposes only.)

A. Soil Preparation: Loosen subgrade of planting beds by crossripping or equivalent cultivation to a minimum depth of ten (10) inches. Remove stones larger than one (1) inch in any dimension and sticks, roots, rubbish, and other extraneous matter in the top six (6) inches of soil and legally dispose of them off Owner's property.

B. Soil Amending: (Amend per Soil-Testing Laboratory recommendations. The following recommendations are provided for bidding purposes only.) Add the following and thoroughly till into the top six (6) inches of planting soil at the following rates per 1,000 square feet. Till planting soil to a homogeneous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter. Float, rake and roll all planter areas to establish finished grades, maintaining drainage patterns and swales for grading and drainage plans, creating smooth, uniform surface plane.

1. 6 cubic yards nitrogen fortified organic soil amendment.
   a. In order to comply with MWEO 492.6, 3. (C). Soil Preparation, Mulch and Amendments, at a minimum, compost shall be applied at a rate of four (4) cubic yards per 1,000 square feet of permeable area incorporated to a depth of six (6) inches into the soil. Soils with greater than six percent (6%) organic matter in the top six (6) inches are exempt from adding compost.

2. 14 pounds all-purpose granular fertilizer (6-20-20).
3. 15 pounds soil sulfur.

C. Fine Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Refer to civil grading plans and conform to designed grades, drainage patterns, swales, and ridges. There shall be no areas that hold water or drain toward buildings or structures, unless designed per civil grading plans.

1. In sodded turf areas, one (1) inch below adjacent paved surfaces, utility boxes, tops of curbs, etc.

D. Moisten prepared lawn areas before planting if planting soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil conditions.

E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted planting soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

3. Hold sod clear of all tree trunks and tree staking, create a circular edge 12" clear of all tree trunks.

C. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist planting soil to a minimum depth of 1-1/2 inches below sod.

3.5 SELECTIVE BROADLEAF WEED KILL

A. Refer to herbicide manufacturer recommendations. Apply selective broadleaf herbicide where indicated prior to disturbing on-site soil per manufacturer recommendations. Re-apply as necessary for complete weed kill by end of maintenance period.

3.6 MAINTENANCE SCHEDULE

A. Protection: Protect work from damage, erosion and trespass. Maintain construction fencing in proper condition. Remove temporary fencing and/or barriers prior to final completion and at end of maintenance period.
B. Water: Contractor shall be solely responsible for ensuring that all planting is sufficiently watered to promote vigorous growth. Test and inspect irrigation system on a regular basis, each week during plant establishment and monthly thereafter. Adjust and repair the irrigation system and its components as necessary for turf establishment and growth and for watering efficiency. Check and adjust any obstructions to emission devices.

C. Fertilizing (confirm with Soil and Plant Laboratory, or approved equal, recommendations): Immediately after completion of planting, fertilize landscape areas with ammonium sulfate (21-0-0) fertilizer at a rate of five (5) pounds per 1000 square feet. Fertilize with specified fertilizer after 45 days, prior to end of maintenance period. After landscape becomes well-established, fertilize in fall and spring with (16-6-8) commercial fertilizer at a rate of six (6) pounds per 1000 square feet.

D. Weed Control: Maintain turf planting areas in a weed-free condition to be performed weekly during maintenance period. Weeding may be done manually or by the use of selective herbicides. Contractor shall obtain written approval from project owner prior to application of herbicide. No herbicide shall be used without the Owner Representative’s prior consent. Use only approved herbicides, use in accordance with manufacturer’s recommendations and per Pest Control Advisor’s recommendations. If selective herbicides are used, extreme caution shall be observed so as not to damage any other plants. Spraying shall be done only under windless conditions. Review and perform weekly during maintenance period.

E. Lawns: Maintain lawns by watering, fertilizing weeding, trimming, mowing and other operations such as rolling, re-grading and replanting as required to establish a smooth, acceptable lawn, free of weeds, bare spots and rocks. All lawn areas shall be mowed regularly when grass reaches a height of three and one-quarter (3-1/4) inches and a minimum of two (2) days prior to end of maintenance period.

F. Disease, Pest and Insect Control: Disease, pest (including moles, gophers and geese) and insect damage shall be controlled by the use of fungicides, insecticides, pesticides, poisons and/or mechanical means. Contractor shall obtain written approval from project Owner prior to application of fungicides, insecticides, poisons, pesticides and/or mechanical means and shall abide by all posting requirements prior to application. Review and perform weekly during maintenance period.

3.7 FIELD QUALITY CONTROL, SUBSTANTIAL COMPLETION AND FINAL COMPLETION

A. Contact Owner’s Representative a minimum of 48 hours prior notice for review and approval of the following prior to proceeding with subsequent work:

1. Preparation: at completion of finish grading and prior to planting, grading tolerances and soil preparation shall be checked for conformance to Drawings and as specified herein.

2. Layout: Layout of all plants, headerboard and other major elements shall be directed and/or approved by the Owner’s Representative.
3. Substantial Completion Review (Pre-maintenance review): At substantial completion of this Section, work shall be reviewed for conformance with the Drawings. Written approval shall mark beginning of the maintenance period.

3. Final Completion Review (Final Review): At the end of specified maintenance period, work shall be reviewed for conformance with Drawings including additional requirements stipulated during maintenance period shall be extended at Contractors sole cost as directed by the Owner's Representative.

4. Re-inspections required due to Contractor not being prepared or non-conformance to Drawings shall be back charged to the Contractor.

B. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

C. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory and upon written approval of Owner.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

END OF SECTION 32 92 00
SECTION 33 05 13.13
MANHOLE GRADE ADJUSTMENT

PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Adjusting manholes, valves, monument covers and other structures to grade.

1.2 RELATED SECTIONS
   A. Section 32 12 00 – Flexible Paving.

1.3 DEFINITIONS

1.4 SUBMITTALS
   A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

1.5 RELATED DOCUMENTS
   A. California Building Code: Section 1127B – Exterior Routes of Travel.

PART 2 PRODUCTS

   NOT USED

PART 3 EXECUTION

3.1 ADJUSTING MANHOLES, VALVES, MONUMENT COVERS AND OTHER STRUCTURES TO GRADE
   A. Remove pavement, using vertical cuts, as needed to remove frame and provide for concrete collar. Do not damage adjacent pavement.
      1. Circular Covers: Cut circle with radius 6 inches larger than cover and concentric with cover.
      2. Rectangular Covers: Cut rectangle 6 inches larger than cover on all sides.
   B. Install grade rings or blocking as needed to raise cover to finish grade.
   C. Pour concrete collar:
      1. Bottom of Collar: Top of existing collar or 6 inches below top of proposed collar, whichever is at a higher elevation.
      2. Top of Collar: Bottom of existing asphalt pavement.
      3. Apply tack coat to all exposed surfaces.
      4. Fill excavation with asphaltic concrete and, while still hot, compact flush with adjacent surface.
3.2 INSTALLATION TOLERANCES

A. Adjust Covers:

1. Compacted surface: Up to 0.01 foot higher, and no lower, than adjacent pavement.

2. Do not create ponding.

END OF SECTION
SECTION 33 05 16

UTILITY STRUCTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Manhole structures for gravity storm drain and sanitary sewer utilities.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling.

1.3 RELATED DOCUMENTS

A. AASHTO:
   1. M 199: Precast Reinforced Concrete Manhole Sections.

B. ASTM:
   1. A 615/A615M: Deformed and Billet-Steel Bars for Concrete Reinforcement.
   2. C 478: Precast Reinforced Concrete Manhole Sections.
   3. C 1244: Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test.

C. Caltrans Standard Specifications.
   1. Section 51, Concrete Structures.
   2. Section 75, Miscellaneous Metal.

D. California Building Code.
   1. Section 1172B – Exterior Routes of Travel.

1.4 DEFINITIONS

A. AASHTO: American Association of State Highway and Transportation Officials.


1.5 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

B. Product data for the following:
   1. Cleanout plugs or caps.

C. Shop drawings: Include plans, elevations, details and attachments for the following:
   1. Precast concrete manholes, frames and covers.
2. Precast concrete clean out boxes and box covers.

D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

E. Field Test Reports: Indicate and interpret test results for compliance with performance.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle precast concrete manholes according to manufacturer’s written instructions.

B. Protect imported bedding and backfill material from contamination by other materials.

2.1 CLEANOUTS

A. Piping: Same as utility line if possible.

B. Top Cap: Threaded and of same material as piping if possible.

C. Box Size: As required to provide access and allow easy removal and reinstallation of cap.

D. Box Types:

1. Landscape Areas: Portland cement concrete box and box cover (bolt-down), light duty.

2. Traffic Areas: Portland cement concrete box and box cover or steel or cast iron cover, heavy duty, both box and cover (bolt down) to be rated for AASHTO H20 loading.

3. Pedestrian Areas: Same as traffic area, with ADA-Compliant cover.

E. Box Cover Markings: “S.D.” for storm drain cleanouts, “S.S.” for sanitary sewer cleanouts, unless otherwise specified.

F. Available Manufacturers: Subject to compliance with requirements, box manufacturers offering products that may be incorporated into the Project include, but are not limited to the following:

1. Brooks Products Inc. (El Monte, California) (Tel. 818-443-3017).

2. Christy Concrete Products, Inc. (Fremont, California) (Tel. 800-486 7070).

2.2 MANHOLES

A. General: Size, shape, configuration, depth, etc. of manhole and frame and cover shall be as indicated.

B. Portland Cement Concrete and Reinforcing:

1. Cast-In-Place Portion: Use Class A Concrete per Caltrans Standard Specification Section 90, and ASTM A615 Grade 60 reinforcing steel bars.

2. Precast Portion: ASTM C 478. Rate for AASHTO H20 loading in traffic areas.

C. Frames and Covers: As indicated and in accordance with Caltrans Standard Specification Section 75-1.02.

D. Steps: ASTM C 478 or AASHTO M 199. Manufacture from deformed, ½-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with
ASTM D4101. Include pattern designed to prevent lateral slippage off step. Acceptable manufacturer is Hanson Concrete Products, (Milpitas, CA) (Tel 408-262-1091) or equal.

2.3 JOINT SEALANT FOR STRUCTURES AND MANHOLES

   1. Use to seal around pipes at connections to structures and manholes. Also use to seal joints between precast sections of structures and manholes.

B. Gaskets: Preformed flexible rubber or plastic gasket.
   2. Plastic Gaskets: Federal Specification SS-S-00210 (GSA-FSS), Type I, Rope Form; or alternate standard which may exist. Acceptable material is “Ram-Nek,” as manufactured by the K. T. Snyder Company (Houston TX), or equal.

PART 3 EXECUTION

3.1 CLEANOUT INSTALLATION

A. General: Install as indicated.

3.2 MANHOLE INSTALLATION

A. General: Install as indicated.

3.3 TESTING OF MANHOLES ON GRAVITY LINES

A. At the option of the Contractor, either the following hydrostatic or vacuum test shall be performed.

B. Hydrostatic Test:
   1. Insert inflatable plugs in all sewer inlets and outlets.
   2. Fill the manhole with water to a point six inches below the base of the manhole frame.
   3. Maintain the water at this point for one hour to allow time for absorption.
   4. Begin one-hour test period. Measure the amount of water added in one-hour period to maintain the water level at six inches below the base of the manhole frame. Do not allow water level to drop more than 25% of the manhole depth.
   5. Determine the allowable leakage by the following formula.
   6. \( L = 0.0002 \times D \times H \times 1/2 \)
   7. \( L = \) Allowable leakage, gallons per minute.
   8. \( D = \) Depth of manhole from top to bottom, feet.
   9. \( H = \) Head of water in feet as measured from the surface of the water in the manhole to the sewer line invert or to the prevailing ground water surface outside the manhole. The lesser height governs.
10. If the leakage exceeds the allowable, determine the cause, take remedial action and re-test the manhole. If the leakage is less than the allowable and leaks are observed, repair the leaks.

C. Vacuum Test:

1. General: Test in accordance with ASTM C 1244.

2. Test prior to backfilling around the manhole.

3. Test Preparation: Plug all lift holes and pipes entering or exiting the manhole.

4. Place test head inside the top section of the manhole's cone section and inflate in accordance with the manufacturer's instructions.

5. Draw a vacuum of 10-inches of mercury and shut the pump off.

6. With the valve closed, the time for the vacuum to drop 9-inches shall be measured.

7. The manhole shall pass the test if the time is greater than 60 seconds for a 48-inch diameter manhole, 75 seconds for a 60-inch diameter manhole and 90 seconds for a 72-inch diameter manhole.

8. If the manhole fails the initial test, make necessary repairs with a non-shrink grout while the vacuum is still being drawn. Retest until a satisfactory test is obtained.

END OF SECTION
SECTION 33 10 00
WATER UTILITIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Site water distribution system for domestic and fire protection services up to 5 feet of any on-site building being served.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling.

1.3 RELATED DOCUMENTS

A. ASTM:


2. B 88: Specifications for Seamless Copper Water Tube.

3. D 1785: Specifications for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.


B. AWWA:


3. C110: Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water.


9. C200: Steel Water Pipe-6 In. (150 mm) and larger.


12. C207: Steel Pipe Flanges for Waterworks Service-Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).


19. C219: Bolted, Sleeve-type Couplings for Plain-End Pipe.


24. C507: Ball Valves 6 In. Through 8 In. (150 mm Through 1,200 mm).

25. C508: Swing-check Valves for Waterworks Service, 2 In. (50mm) Through 24 In. (600 mm) NPS.


27. C510: Double Check Valve Backflow-Prevention Assembly.

28. C511: Reduced-Pressure Principle Backflow-Prevention Assembly.


33. C606: Grooved and Shouldered Joints.

34. C651: Disinfecting Water Mains.


36. C900: Polyvinyl Chloride (PVC) Pressure Pipe and Fittings, 4 In. Through 12 In. (100mm Through 300mm) for Water Distribution.

37. C901: Polyethylene (PE) Pressure Pipe and Tubing, ¼ In. (13mm) Through 3 In. (76mm) for Water Service.
38. C905: Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. Through 48 in. (350 mm Through 1,200 mm) for Water Transmission and Distribution.

39. C906: Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) through 63 in (1,575 mm), for Water Distribution and Transmission.

40. C907: Polyvinyl Chloride (PVC) Pressure Fittings for Water – 4 in. through 8 in. (100 mm Through 200 mm).


44. M41: Ductile-Iron Pipe and Fittings.

1.4 DEFINITIONS

A. AASHTO: American Association of State Highway and Transportation Officials.


C. AWWA: American Waterworks Association

D. DI: Ductile iron.

E. DIP: Ductile iron pipe.

F. FM: Factory Mutual.


H. NSF: National Sanitation Foundation.


J. PE: Polyethylene.

K. PVC: Polyvinyl Chloride.

L. UL: Underwriters Laboratory.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

A. Minimum Internal Pressures: As indicated on plans.

B. External Load: Earth load indicated by depth of cover plus AASHTO H20 live load unless indicated otherwise.

1.6 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

B. Product Data: For the following:

1. Piping materials and fittings.
2. Pipe couplings.
3. Flexible pipe fittings.
4. Restrained pipe fittings.
5. High deflection fittings/ball joints.
7. Flexible expansion joints.
8. Gate valves.
10. Check valves.
11. Air and vacuum relief valves.
13. Pressure reducing valves.
14. Pressure sustaining valves.
15. Ball valves.
16. Fire hydrants.
17. Post indicator valves.
18. Fire department connections.
20. Precast valve boxes and box covers.

C. Shop drawings: Include plans, elevations, details and attachments.
   1. Precast and cast in-place vaults and covers.
   2. Wiring diagrams for alarm devices.

D. Field test reports: Indicate and interpret test results for compliance with the Project requirements.

1.7 QUALITY ASSURANCE

A. Comply with requirements of utility supplying water. Do not operate existing valves or tap existing piping without written permission and/or presence of utility company representative.

B. Comply with the following requirements and standards:
   1. NSF 61: "Drinking Water System Components-Health Effects" for materials for potable water.
2. NFPA 24: "Installation of Private Fire Service Mains and Their Appurtenances" for materials, installations, tests, flushing, and valve and hydrant supervision.


C. Provide listing/approval stamp, label, or other marking on piping and specialties made to a specified standard.

1.8 MATERIAL DELIVERY, STORAGE AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
   1. Ensure that valves are dry and internally protected against rust and corrosion.
   2. Protect valves against damage to threaded ends and flange faces.

B. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage and handling to prevent pipe end damage and to prevent entrance of dirt, debris and moisture.

C. Handling: Use slings to handle valves and fire hydrants whose size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. During Storage: Use precautions for valves, including fire hydrants according to the following.
   1. Do not remove end protectors, unless necessary for inspection, then reinstall for storage.
   2. Protection from Weather: Store indoors and maintain temperature higher than ambient dewpoint temperature. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

E. Do not store plastic pipe and fittings in direct sunlight.

F. Protect pipe, fittings, flanges, seals and specialties from moisture, dirt and damage.

G. Protect linings and coatings from damage.

H. Handle precast boxes, vaults and other precast structures according to manufacturer’s written instructions.

I. Protect imported bedding and backfill material from contamination by other materials.

1.9 COORDINATION

A. Coordinate connection to existing water mains with water utility supplying water.

B. Coordinate piping materials, sizes, entry locations, and pressure requirements with building domestic water distribution piping and fire protection piping.

PART 2 PRODUCTS

2.1 GENERAL
A. Products and Materials listed below are acceptable unless otherwise specified within the construction documents.

2.2 SMALL-SIZE SERVICE PIPES

A. Copper Pipe: Sizes $\frac{3}{4}$-inch through 2-inch.
   2. Joints: Restrain by couplings.

B. PE Plastic Pipe: Sizes $\frac{1}{2}$-inch through 3-inch.
   1. Pipe and Fittings: AWWA C901.
   2. Joints: Restrain with clamps or heat-fusion.

2.3 LARGE-SIZE SERVICE AND DISTRIBUTION PIPES

A. DIP: Sizes 4-inch through 48-inch.
   2. Fittings
      a. Standard: AWWA C110, sizes 4-inch through 48-inch.
      b. Compact: AWWA C153, sizes 4-inch through 24-inch.
   3. Pipe and Fitting Lining: Cement Mortar, AWWA C104.
   4. Pipe and Fitting Coating: Asphalctic, AWWA C151 or C115.
   6. Unrestrained Joints:
      a. Push-On Bell and Spigot Joint: AWWA C111.
      b. Mechanical Joint: AWWA C111.
   7. Restrained Joints:
      a. Flanged Joint: AWWA C115.
      b. Push-On Bell and Spigot Joint: AWWA C111 with "Field Lok Gasket," sizes 4-inch through 24-inch; "TR Flex," sizes 4-inch through 64-inch; both by U. S. Pipe (Birmingham AL) (Tel.205-254-7442) or approved equal. "Megalug" restraint harness, Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.
      c. Mechanical Joint: AWWA C111 with "Mega Lug," sizes 3-inch through 48-inch. Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.
      d. Grooved and Shouldered Joints: AWWA C150, AWWA C151 and AWWA C606. 24-inch maximum size.
   8. Couplings:
a. Plain End Pipe to Plain End Pipe: Ductile iron or steel bolted couplings, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.

b. Plain End Pipe to Flanged Pipe: 1) Ductile iron or steel bolted flanged coupling adapters, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel flanged couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal; or 2) restrained flange adapter, “Megaflange,” sizes 3-inch through 36 inch, Ebaa Iron (Eastland TX ) (Tel 800-443-1716) or approved equal.

B. PE Pipe: Sizes 4-inch through 64-inch.

1. Pipe and Fittings: AWWA C906.

2. Joints:
   a. Thermal Butt Fusion: AWWA C906 and pipe manufacturer’s recommendations.
   b. Flanged joining: AWWA C906 and pipe manufacturer’s recommendations.
   c. Other: Check with pipe manufacturer.

C. PVC Pipe: Sizes 4-inch through 48-inch.

1. Pipe:
   a. 4-inch through 12-inch: AWWA C900, Class 200.
   b. 14-inch through 48-inch: AWWA C905.

2. Fittings: DI conforming to 2.2A above.

3. Unrestrained Joints:

4. Restrained Joints:
   a. Push-On Bell and Spigot Joint: Harness assembly as manufactured by Ebaa Iron (Eastland, Tx) (Tel. 800-433-1716) or approved equal.
   b. Plain End PVC to DI Mechanical Joint: Ebaa Iron (Eastland, Tx) (Tel. 800-433-1716) or approved equal.

5. Steel or Ductile Iron Couplings:
   a. Plain End Pipe to Plain End Pipe: Ductile iron or steel bolted couplings, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.
   b. Plain End Pipe to DI or Steel Flanged Pipe: Ductile iron or steel bolted flanged coupling adapters, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel flanged
couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.

6. PVC Couplings
   a. Unrestrained Plain End to Plain End Pipe: AWWA C900, as manufactured by CertainTeed (Valley Forge, PA) (Tel. 610 341-6820) or approved equal.
   b. Restrained Plain End to Plain End Pipe: AWWA C900, “Certa-Lock” as manufactured by CertainTeed (Valley Forge, PA) (Tel. 610 341-6820) or approved equal.

D. Cement Mortar Lined and Coated Steel Pipe: 6-inch and larger.

1. Pipe: AWWA C200 and AWWA M11.

2. Special Sections and Fittings: AWWA C200, C207, C208 and AWWA M11 for all bends, tees, nozzles, closures, etc.


4. Linings and Coatings for Pipe, Special Sections and Fittings: Cement Mortar Lining and Coating: AWWA C205.
   b. Fusion Bonded Epoxy Lining and Coating: AWWA C213.
   c. Coal-Tar Lining and Coating: AWWA C203.
   e. Cold-Applied Tape Coatings, Specials, Connection and Fittings: AWWA C209.
   f. Cold Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Buried or Submerged Steel Water Pipelines.
   g. Aboveground Pipe Coatings: AWWA C218.

   a. Rubber Gasket: Carnegie-shape rubber gasket as indicated.

6. Restrained Joints: AWWA M11. Where a flanged joint, butt strap or coupling are not indicated, either restrained joint a, or b, as follows, is acceptable, but the selected joint shall be used throughout the project.
   a. Rubber Gasket: Carnegie-shape rubber gasket with field welded restraint bar as indicated.
   b. Field Lap Welded Slip Joint: As indicated.
   c. Field Welded Butt Strap: As indicated.
   d. Flanged Joint: AWWA C207 with Type 316L stainless steel bolts and nuts as indicated.

7. Joint Coating for Cement Mortar Lined and Coated Steel Pipe:
a. Field Joint Encasement: Cement mortar contained in fabric lined with closed cell polyethylene foam as indicated. Attach fabric to pipe with Type 316L stainless steel straps as indicated. Closed cell polyethylene foam encasement shall be by Industrial Specialties (Fullerton, CA) (Tel. 800-638-8127) or approved equal.

8. Non-Restrained Flexible Couplings: AWWA C219, Smith Blair, Inc (Texarkana, TX) (Tel. 501-773-5127), Number 411 or approved equal, with factory applied fusion-bond epoxy coating and Type 316L stainless steel bolts and nuts.

9. Restrained Flexible Couplings: Non-restrained flexible coupling supplemented with a restraining harness as indicated and as follows:
   a. Restraining harness design by Contractor’s pipe manufacturer using criteria presented in Section 13.10 of AWWA M11.
   b. Space harness-lugs and tie bolts equally around the pipe.
   c. Type 316L stainless steel harness tie bolts and nuts.
   d. Design and dimensions of harness lugs to be modified from that shown in AWWA M11, as necessary, to provide additional height to clear the coupling.

10. Field Coating of Coupling Assemblies: Apply either of the following flexible tape and mastic or putty coating systems to the all non-restrained or restrained flexible steel couplings.
    b. Trenton Coating System – Allied Utility Products, (Livermore, CA) (Tel. 510-484-4007 or 510-373-7400).

2.4 HIGH DEFLECTION FITTINGS/BALL JOINTS

A. Plain End Pipe: Xtra Flex Restrained Joint High Deflection Fittings, 4-inch through 24-inch, U. S. Pipe, (Birmingham, AL) (Tel. 205-254-7442) or approved equal.

B. Mechanical or Flanged Joint: Flex 900, 4-inch through 12-inch, Ebaa Iron Sales, (Eastland, TX) (Tel. 800-433-1716) or approved equal.

2.5 EXPANSION JOINTS

A. TR Flex Joints: TR Flex Telescoping Sleeve, 4-inch through 64 inch, U. S. Pipe, (Birmingham, AL) (Tel. 205-254-7442).

B. Mechanical or Flanged Joint: Ex-Tend 200, 4-inch through 36-inch, EBAA Iron Sales, (Eastland, TX) (Tel. 800-433-1716) or approved equal.

2.6 FLEXIBLE EXPANSION JOINTS

A. Plain End to Plain End Pipe: “Xtra Flex,” sizes 4-inch through 24-inch, U. S. Pipe, (Birmingham AL) (Tel. 205-254-7442) or equal.

B. Flanged or mechanical Joint: “Flex-Tend,” sizes 3-inch through 48-inch, Ebaa Iron (Eastland TX) (Tel. 800-433-1716) or equal.

C. Flanged Joint: Starflex, Series 500, Star Pipe Products, (Tel. 800-999-3009) or equal.
2.7 GATE VALVES

A. Provide on lines 10-inch and smaller.

B. Valves, 3-Inch through 20-Inch: AWWA C509, resilient-seat ed, non-rising stem, gray or ductile-iron body and bonnet, with bronze or gray or ductile-iron gate, bronze stem and square stem operating nut unless noted otherwise. All bolts, nuts and washers, except operating nut, shall be stainless steel. Stem operating nut to be 2-inches square and open counter-clockwise. Stem extensions shall be installed to bring the stem operating nut to within 2-feet of finish grade where the depth from finish grade to the stem operating nut exceeds 4-feet. Equip valves in pump stations and other interior or vault installations with hand-wheels. Provide protective epoxy interior and exterior coating according to AWWA C550 and manufacturer’s recommendations.

C. Service Line Valves and Fittings, 2-Inch and Smaller: AWWA C800

D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Mueller Company (Decatur, IL) (Tel.800-423-1323).

E. Valve Box and Cover: 9-inch minimum diameter PCC box with extensions of length required for depth of bury of valve, and cast iron or ductile iron cover with lettering “WATER”. Both the box and the cover shall be rated for AASHTO H20 loading.

2.8 BUTTERFLY VALVES

A. Provide on lines larger than 10-inch.

B. Valves, 3-Inch through 72-Inch: AWWA C 504, rubber seated, Class 150B cast iron body, cast or ductile iron discs, stainless steel shafts, adjustable field replaceable rubber seats mating against stainless steel seat rings and field-replaceable seals. Flanged or mechanical joint end connections. No wafer type valves allowed. Traveling nut type valve actuators designed for buried service unless noted otherwise. All bolts, nuts and washers, except wrench nut, shall be stainless steel. Wrench nut to be 2-inches square and open counter-clockwise. Stem extensions shall be installed to bring the wrench nut to within 2-feet of finish grade where the depth from finish grade to the wrench nut exceeds 4-feet. Equip valves in pump stations and other interior or vault installations with hand-wheels. Provide protective epoxy interior and exterior coating according to AWWA C550 and manufacturer’s recommendations.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Mueller Company (Decatur, IL) (Tel.800-423-1323).

D. Valve Box and Cover: 9-inch minimum diameter PCC box with extensions of length required for depth of bury of valve, and cast iron or ductile iron cover with lettering “WATER”. Both the box and the cover shall be rated for AASHTO H20 loading.
2.9 AIR RELEASE, AIR/VACUUM AND COMBINATION AIR VALVES

A. AWWA C512, specific type of valve, size, details and valve box as indicated.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Apco Valves, Valve and Primer Corporation (Schaumburg, IL) (Tel. 708-529-9000).
2. Crispin Valve (Berwick, PA) (Tel. 800-247-8258).

2.10 BLOW-OFF VALVES

A. Blow-off valve assemblies, details and boxes as indicated.

2.11 SWING CHECK VALVES

A. Valves 2-Inch through 24-Inch: AWWA C508, details as indicated.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Mueller Company (Decatur, IL) (Tel. 800-423-1323).

2.12 BALL VALVES

A. Valves 6-Inch through 48-Inch: AWWA C507, details as indicated.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:


2.13 PRESSURE-REGULATING VALVES

A. Valve: Automatic, pilot-operated, cast-iron body with interior coating according to AWWA C550. 250-psi Working-pressure, bronze pressure-reducing pilot valve and tubing, and means for discharge pressure adjustment. Details as indicated.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).
2. Bermad (Porterville, CA) (Tel. 209-781-6630).
3. Ames Company (Woodland, CA) (Tel. 916-666-2493).

2.14 FLOW-REGULATING VALVES

A. Valve: Automatic, pilot-operated, cast-iron body with interior coating according to AWWA C550. 250-psi working-pressure, bronze pressure-reducing pilot valve and tubing, and means for flow adjustment. Details as indicated.
B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).
2. Bermad (Porterville, CA) (Tel. 209-781-6630).
3. Ames Company (Woodland, CA) (Tel. 916-666-2493).

2.15 SERVICE CONNECTIONS AND WATER METERS

A. Service connections and water meter details and boxes as indicated.

2.16 FIRE HYDRANTS

A. Wet Barrel: AWWA C503, details as indicated.
B. Dry Barrel: AWWA C502, details as indicated.

2.17 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER

A. Provide as indicated and as required by State or local agency.
B. General: AWWA C511, with OS gate valve on inlet and outlet, and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air gap fitting located between 2 positive-seating check valves for continuous-pressure application.
C. Body:
   1. 2-Inch and Smaller: Bronze with threaded ends.
   2. 2-1/2-Inch and Larger: Bronze, cast iron steel, or stainless steel with flanged ends.
D. Interior Lining: AWWA C550, epoxy coating for cast iron or steel bodies.
E. Interior Components: Corrosion-resistant materials.
F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
   1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).
   2. Ames Company (Woodland, CA) (Tel. 916-666-2493).
   3. Febco, CMB Industries, Inc. (Fresno, CA) (Tel. 559-252-0791).
   4. Hersey Products, Inc. (Dedham, MA) (Tel. 617-326-9400).

2.18 DOUBLE CHECK DETECTOR ASSEMBLY

A. FM approved or UL listed, with OS&Y gate valve on inlet and outlet, and strainer on inlet. Include two positive-seating check valves and test cocks, and bypass with displacement-type water meter, valves, and double-check backflow preventer, for continuous pressure application.
B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
   1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).
2. Ames Company (Woodland, CA) (Tel. 916-666-2493).
3. Febco, CMB Industries, Inc. (Fresno, CA) (Tel. 559-252-0791).
4. Hersey Products, Inc. (Dedham, MA) (Tel. 617-326-9400).

2.19 POST INDICATOR VALVE

A. General: UL 789, FM approved, vertical-type, cast-iron body with operating wrench extension rod, and adjustable cast-iron barrel of length required for depth of bury of valve. Review fire department connection with agency having jurisdiction. Check hose threads and all sizes with fire department.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
   1. Mueller Co. (Decatur, IL) (Tel. 800-423-1323).
   2. Clow Corporation (Oskaloosa, IA).

2.20 FIRE DEPARTMENT CONNECTION

A. Exposed, Freestanding Fire Department Connection: UL 405, cast brass body with threaded inlets according to NFPA 1963 and matching local fire department hose threads and threaded bottom outlet. Include lugged caps, gaskets and chains; lugged swivel connections and drop clapper for each hose-connection inlet.

2.21 UNDERGROUND VAULTS/PITS

A. General: Portland cement concrete, precast or cast-in-place as indicated.

B. Portland Cement Concrete and Reinforcing Steel: Section 32 05 23 – Cement and Concrete for Exterior Improvements.

C. Access Openings: As indicated.

D. External Load: Earth load plus AASHTO H20 live load if located in paved areas.

E. Lids: Bolt down type.

2.22 TRACER WIRE

A. General: Minimum #12 AWG stranded copper wire with blue THW, THWN, or THHN rated insulation.

2.23 WARNING TAPE

A. General: Non-detectable 3-inch warning tape made of solid blue film with continuously printed black-letter message reading “CAUTION—WATER LINE BURIED BELOW.”

2.24 PCC THRUST BLOCKS

A. Portland Cement Concrete and Reinforcing Steel: Section 32 05 23 – Cement and Concrete for Exterior Improvements.

PART 3 EXECUTION
3.1 PIPE INSTALLATION

A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer’s instructions, and in accordance with the following:

1. DIP: AWWA M41 and AWWAC600.
2. PVC pipe: AWWA M23 and AWWA C605.

B. Pipe Depth and Trench Configuration: Conform to elevations, profiles and typical trench section(s) indicated.

C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.

D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with manufacturer’s recommendations.

E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Lay pipe on a bed of bedding material specified and prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout its entire length with bell holes provided at the ends of each pipe length of sufficient size to permit making up the particular type of joint being used. Adjust pipe to line and grade by scraping away or filling and tamping material under the body of the pipe for the entire pipe length and not by blocking or wedging. After final positioning, hold pipe in place in trench with backfill material placed equally on both sides of the pipe at as many locations as required to hold the pipe section in place.

F. Curved Alignment: When necessary to conform to the alignment specifically indicated, lay pipe on a curved alignment by means of asymmetrical closure of joints or bending of the pipe barrel. If necessary, use shorter than the standard lengths of pipe to achieve curvature specified. Do not exceed the recommendations of the pipe manufacture for deflections at the joints or pipe bending.

G. Closure: Close open ends of pipes and appurtenance openings at the end of each days work or when work is not in progress.

3.2 CONNECTING TO EXISTING MAINS

A. Pressure Tap Connections: Perform in accordance with the requirements of the owner of the system being tapped. Maintain a positive pressure flow from the main being tapped to the tapping device to flush plastic chips, metal ribbons, etc. into the tapping devise and not into the pipe being tapped.

B. Other Connections: As indicated and in accordance with the requirements of the owner of the line being connected to.

3.3 ANCHORAGE INSTALLATION

A. Mechanically Restrained Joints: Install where indicated for lengths indicated in accordance with manufacturer’s instructions.
B. PCC Thrust Blocks: Install where required and as indicated. Bearing area indicated is to be against undisturbed earth. Allow a minimum of 24-hours curing time before introducing water into the pipeline and allow a minimum of 7-days curing time before pressure testing.

3.4 HIGH DEFLECTION FITTINGS/BALL JOINTS, EXPANSION JOINTS, AND FLEXIBLE EXPANSION JOINTS

A. Install as indicated and in accordance with the manufacturers recommendations.

3.5 VALVE INSTALLATION

A. Install all valves in accordance with the manufacturer’s instructions and the following:

1. General:
   a. Gate Valves: Appendix A of AWWA C509.

2. Joints:
   b. Valves on Steel Pipe: As indicated for buried locations. Flanged-end valves for installation in vaults/pits.

3.6 SERVICE CONNECTIONS INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system.

3.7 WATER METER INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system.

3.8 FIRE HYDRANT INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.9 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the local health department requirements.

3.10 DOUBLE CHECK DETECTOR ASSEMBLY INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.11 POST INDICATOR VALVE INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.12 FIRE DEPARTMENT CONNECTION INSTALLATION
A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.13 UNDERGROUND VAULT/PIT INSTALLATION

A. Install as indicated.

B. Excavation and Backfill: Section 31 23 33 – Trenching and Backfilling.

3.14 TRACER WIRE INSTALLATION

A. Install on trench bottom under the vertical projection of the pipe to protect it in all installations.

B. Form a mechanically and electrically continuous line throughout the pipeline, extending to the nearest valve or other pipeline appurtenance designated by the owner of the system or the Owner. Extend the wire up the outside of the valve box/riser and cut a hole that is 8-inches from the top, extend a 12-inch wire lead to the inside of the box. At other pipeline appurtenances, designated by the owner of the system or the Owner, terminate the 12-inch wire lead inside the enclosure.

C. Splice wire with a splicing device consisting of and electro-tin plated seamless copper sleeve conductor. Install as recommended by the manufacturer. Wrap splices and damaged insulation with electrician’s tape.

3.15 WARNING TAPE INSTALLATION

A. Install tape approximately 1-foot above and along the centerline of the pipe.

B. Where tape is not continuous, lap tape ends a minimum of 2-feet.

3.16 HYDROSTATIC PRESSURE AND LEAKAGE TEST

A. General:

1. Provide all necessary materials and equipment, including water.

2. Backfill all trenches sufficient to hold pipe firmly in position.

3. Allow time for thrust blocks to cure prior to testing.

4. Flush all pipes prior to testing to remove all foreign material.

5. Perform pressure and leakage test concurrently.

6. Test pressure: See Subsection titled “System Performance Requirements.”

7. Apply test pressure by means of a pump connected to the pipe.

8. Base test pressure on the elevation of the lowest point in the line.

9. Fill each closed valve section or bulk-headed section slowly. Expel air from section being tested by means of permanent air vents installed at high points or by means of temporary corporation cocks installed at such points. Remove and plug the temporary corporation cocks at the conclusion of the test.

10. Allow water to stand in the pipe for 24 hours before test pressure is applied.

11. Allow the system to stabilize at the test pressure before conducting the leakage test.
12. Do not operate valves in either the opening or closing direction at differential pressures above the valves rated pressure.

13. Maintain test pressure as specified for type of pipe being tested.

14. Pressure Test: Examine any exposed pipe, fittings, valves, hydrants and joints during the test, if no leaks are observed the section of line has passed the pressure test. If leaks are observed, repair any damaged or defective pipe, fittings, valves, or hydrants, and repeat the pressure test.

15. Leakage Test: Perform as specified hereafter for the type of pipe being installed.

B. DIP Leakage Test: Perform in accordance with AWWA C600. Selected requirements of AWWA C600 are repeated as follows:

1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.

2. No piping will be accepted if the leakage is greater than that determined by the following formula:

3. \[ L = \frac{(S \times D \times P_{1/2})}{133,200} \]

4. \( L = \) Allowable leakage, gallons per hour.

5. \( S = \) Length of pipe tested, feet.

6. \( D = \) Nominal diameter of pipe, inches.

7. \( P = \) Average test pressure during the leakage test, pounds per square inch (gauge).

C. PE Pipe Leakage Test:

1. Apply the test pressure and allow the pipe to stand, without makeup pressure, for sufficient time to allow for diametric expansion or pipe stretching to stabilize, approximately two to three hours.

2. After the above stabilization has occurred, return the section being tested to the test pressure. Hold the test pressure for one to three hours. If the pressure in the test section drops, and it is determined the drop may be the result of expansion resulting from increasing temperature, a limited amount of additional water may be added to bring the pressure back to the test pressure. Allowable amounts of make-up water, to compensate for expansion due to increasing temperature, are as shown in the following table. Make-up water is only allowed during this final test period and not during the initial stabilization described in the previous paragraph. If the additional water added is less than the allowable shown in the table and there are no visual leaks or significant pressure drops, the tested section passes the test.

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>Allowance for Expansion (U.S. Gals./100 Feet of Pipe)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-Hour</td>
</tr>
<tr>
<td>Test</td>
<td>Test</td>
</tr>
<tr>
<td>3</td>
<td>0.10</td>
</tr>
<tr>
<td>4</td>
<td>0.13</td>
</tr>
<tr>
<td>6</td>
<td>0.30</td>
</tr>
<tr>
<td>8</td>
<td>0.50</td>
</tr>
</tbody>
</table>
10 0.75 1.3 2.1
11 1.0 2.0 3.0
12 1.1 2.3 3.4
14 1.4 2.8 4.2
16 1.7 3.3 5.0
18 2.2 4.3 6.5
20 2.8 5.5 8.0
22 3.5 7.0 10.5
24 4.5 8.9 13.3
28 5.5 11.1 16.8
32 7.0 14.3 21.5
36 9.0 18.0 27.0
40 11.0 22.0 33.0
48 15.0 27.0 43.0

D. PVC Pipe Leakage Test: Perform in accordance with AWWA M23. Selected requirements of AWWA M23 are repeated as follows:

1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.
2. No piping will be accepted if the leakage is greater than that determined by the following formula:

   \[ L = \frac{(N \times D \times P/2)}{7,400} \]

3. \( L \) = Allowable leakage, gallons per hour.
4. \( N \) = Number of joints in the length of the pipeline tested.
5. \( D \) = Nominal diameter of pipe, inches.
6. \( P \) = Average test pressure during the leakage test, pounds per square inch (gauge).

E. Cement Mortar Lined and Coated Steel Pipe Leakage Test: Perform in accordance with AWWA M11. Selected requirements of AWWA M11 are repeated as follows:

1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.
2. There shall be no significant leakage for pipe with welded joints or mechanical couplings.
3. For pipe joined with O-ring rubber gaskets, a leakage of 25 gallons per inch of diameter per mile per 24-hours is allowed.

3.17 FLUSHING

A. Following assembly and testing and prior to disinfection & final acceptance, all potable water pipelines installed under this section must be flushed with water and all accumulated construction debris and other foreign matter removed. Use only potable water for flushing potable water pipelines. Flushing velocities must be a minimum of 2.5-feet per second. Cone strainers must be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the CDCR Representative. Accumulated debris must be removed through drains two inches and larger or by dropping spools and valves.

3.18 DISINFECTION
A. All New Pipelines shall be disinfected in accordance with one of the three methods specified in AWWA C651 and the following:

1. Disinfect after pressure and leakage test have been performed and accepted and after flushing.

2. The method used shall be at the Contractor's option, unless specified by the owner of the water system.

3. Engage the services of a commercial testing laboratory, approved by the owner of the water system, to perform the bacteriological tests specified in Section 5.1 of AWWA C651. Direct the testing laboratory to send the original report of the bacteriological testing to the owner of the water system. Should the laboratory report show that any sample taken was not acceptable, repeat the sterilization process shall until a satisfactory sterilization is accomplished.

4. Lawfully dispose of the chlorinated water.

END OF SECTION
SECTION 33 30 00
SANITARY SEWERAGE UTILITIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Roadway and/or site sanitary gravity sewers and force mains up to 5 feet of any on-site building.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling.

B. Section 33 05 16 – Utility Structures.

1.3 RELATED DOCUMENTS

A. AASHTO:

1. M 252: Corrugated Polyethylene Drainage Tubing.

2. M 294: Corrugated Polyethylene Pipe, 12 to 24-inch Diameter.

B. ASTM:

1. A 615/A615M: Deformed and Billet-Steel Bars for Concrete Reinforcement.

2. A 674 Practice for Polyethylene Encasement for Ductile Iron Pipe for Water and Other Liquids.


5. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.


10. D 3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.


15. F-1336: Poly(Vinyl Chloride) (PVC) Gasket Sewer Fittings.

C. AWWA:
   3. C110: Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (76 mm Through 1,219 mm) for Water.

D. Caltrans Standard Specifications.
   1. Section 65, Reinforced Concrete Pipe.

E. California Building Code.

F. Section 1806A.11 – Pipes and Trenches.

G. California Plumbing Code.

1.4 DEFINITIONS
   A. AASHTO: American Association of State Highway and Transportation Officials.
   E. HDPE: High-density polyethylene.
   F. PE: Polyethylene.
   G. DIP: Ductile iron pipe.
   H. PVC: Polyvinyl Chloride.
   I. RCP: Reinforced concrete pipe.
   J. NPS: Nominal pipe size.

1.5 SUBMITTALS
   A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
   B. Product data for the following:
1. Piping materials and fittings.
2. Special pipe couplings.
4. Sewage air relief valves.

C. Shop drawings: Include plans, elevations, details and attachments for the following:
   1. Force main piping access openings.

D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

E. Field Test Reports: Indicate and interpret test results for compliance with performance.

1.6 DELIVERY, STORAGE AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.
B. Protect pipe, fittings, and seals from dirt and damage.
C. Handle precast concrete pipe and other precast structures according to manufacturer’s written instructions.
D. Protect imported bedding and backfill material from contamination by other materials.

PART 2 PRODUCTS

2.1 GENERAL

A. Products and materials listed are acceptable unless otherwise specified within the construction documents.

2.2 PIPING MATERIALS FOR GRAVITY FLOW

A. DIP: Sizes 4-inch through 48-inch.
   2. Pressure Class: Minimum pressure class for size indicated.
   3. Fittings
      a. Standard: AWWA C110, sizes 4-inch through 48-inch.
      b. Compact: AWWA C153, sizes 4-inch through 24-inch.
   4. Pipe and Fitting Lining: Cement Mortar, AWWA C104.
   5. Pipe and Fitting Coating: Asphalitic, AWWA C151 or C115.
   7. Joints:
      a. Push-On Bell and Spigot Joint: AWWA C111.
b. Mechanical Joint: AWWA C111.

c. Flanged joint. AWWA C115.

B. PVC Pipe and Fittings: 4-inch through 15-inch, SDR 26, ASTM D 3034. Bell and spigot joints.


2. Fittings: ASTM F 1336.

2.3 SPECIAL PIPE COUPLINGS

A. Gravity Piping: ASTM C 1173. Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.

2.4 MANHOLES AND CLEANOUTS

A. See Section 33 05 16 – Utility Structures.

PART 3 EXECUTION

3.1 GRAVITY PIPE INSTALLATION

A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer’s instructions, and in accordance with Section 6 and 7 of ASTM D 2321 for plastic pipe, Caltrans Standard Specification Section 65-1.07 for reinforced concrete pipe and chapter 11.3.3 of AWWA M41 for ductile iron pipe.

B. Pipe Depth and Trench Configuration: Conform to typical trench section(s) indicated.

C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.

D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with the manufacturer’s recommendations.

E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Start laying the pipeline at the low end and proceed upstream. Lay bell and spigot pipe with the bell end facing upstream. Lay pipe on a bed prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout it’s entire length with bell holes provided at the ends of each pipe length of sufficient size to permit making up the particular type of joint being used. Adjust pipe to line and grade by scraping away or filling and tamping material under the body of the pipe for the entire pipe length and not by blocking or wedging. After final positioning, hold pipe in place in trench with backfill material placed equally on both sides of the pipe at as many locations as required to hold the pipe section in place.

F. Curved Alignment: When necessary to conform to the alignment specifically indicated, lay pipe on a curved alignment by means of asymmetrical closure of joints or bending of the pipe barrel. Use shorter lengths of pipe than the standard length if necessary to achieve curvature specified. Do not exceed the recommendations of the pipe manufacture for deflections at the joints or pipe bending.

G. Closure: Close open ends of pipes and appurtenance at the end of each days work or when work is not in progress.

3.2 SPECIAL PIPE COUPLINGS
A. General: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

B. Installation: Per manufacturer's instructions.

3.3 TESTING OF GRAVITY PIPING MAINS

A. Obstructions: After backfilling and compacting, but before paving or other surface improvements, test sewer for obstructions either by rodding or by the sewer ball method. Provide for intercepting all grit, rocks and other flushed debris to keep debris from entering the existing system.

B. At the option of the Contractor, either the following hydrostatic or air test shall be performed.

C. Hydrostatic Test:
   1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.
   2. Test sewer mains between successive manholes by closing the lower end of the sewer main to be tested and the inlet sewer main of the upper manhole with stoppers.
   3. Fill pipe and manholes with water to a point four feet below the ground surface of the upper manhole, but in no case less than four feet above the pipe invert. If ground water is present, the water surface at the upper manhole shall be at least four feet above the level of the ground water.
   4. Fill piping at least one hour prior to testing.
   5. Test piping at least two hours by maintaining the head specified above with measured additions of water. The sum of these additions of water, in the two-hour test period, shall be the leakage amount.
   6. The maximum allowable head of water above any portion of sewer being tested shall be 15-feet. Where the difference in elevation between successive manholes exceeds 15-feet, a test tee shall be installed between manholes, and the testing shall be carried on between the tee and the manhole.
   7. The allowable leakage shall not exceed 0.1-gallons per minute per inch diameter, per 1000-feet of sewer main being tested.
   8. If the leakage exceeds the above amount, determine the cause and remedy it prior to retesting.
   9. If the leakage is less than the allowable, but leaks are observed, repair the observed leaks.

D. Air Test:
   1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.
   2. Apply to each length between adjacent manholes.
   3. Supply pressure gauge with minimum divisions of 0.10-psi and with an accuracy of +/- 0.04-psi. When requested by the Owner, provide certification that the gauge has been tested for accuracy within the last six months by a reliable testing firm.
   4. Pressurize the test section to 3.5-psi, and then hold the pressure above 3.0-psi during a saturation period of at least 5 minutes. At the end of the saturation period, note the pressure, which must be a minimum of 3.0-psi, and begin the timed period. If the pressure drops 0.5-
psi in less than the time given in the following table the section of pipe has not passed the test.

5. **Pipe Size** | **Minimum Time Allowed for Pressure to Drop 0.5-PSI**
--- | ---
4" | 125 seconds
6" | 185 seconds
8" | 245 seconds
10" | 310 seconds
12" | 370 seconds
15" | 460 seconds
18" | 555 seconds
21" | 10 minutes
24" | 12 minutes
27" | 14 minutes
30" | 16 minutes
36" | 18 minutes
42" | 20 minutes
48" | 23 minutes
54" | 26 minutes

6. If the time for the pressure to drop 0.5-psi is 125% or less of the time indicated, the line shall immediately be re-pressurized to 3.0-psi and the test repeated. If, during the 5-minute saturation period, the pressure drops less than 0.5-psi after the initial pressurization and air is not added, the section undergoing the test shall have passed.

7. If the test did not pass, find and repair the leak to the satisfaction of the Owner.

8. When the prevailing ground water is above the line being tested the air pressure shall be increased 0.43-psi for each foot the water table is above the invert of the pipe at the highest manhole.

3.4 **TESTING OF LATERALS**

A. At the option of the Contractor, either the following hydrostatic or air test shall be performed.

B. Hydrostatic Test:

1. Test laterals before backfilling.

2. Plug lateral at its ends and fill with water through the cleanouts.

3. Maintain the water level in the cleanouts as high as possible throughout the test period.
4. One hour after filling with water, examine the lateral for leakage.

5. Repair all leaks to the satisfaction of the Owner.

6. Do not backfill the trench until testing and repairs of the lateral are complete, and approved by the Owner.

7. Following approval of the Owner, remove all plugs, dispose of the water and complete the connection to the main.

C. Air Test

1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.

2. Test in accordance with subsection above titled “Testing of Gravity Piping Mains,” paragraph titled “Air Test.”

3.5 HYDROSTATIC AND LEAKAGE TESTING OF FORCE MAINS

A. General: Perform hydrostatic and leakage test in accordance with Section 33 10 00 – Water Utilities.

3.6 FLUSHING

A. Following assembly and testing and prior to final acceptance, sewer pipelines must be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities must be a minimum of 2.5-feet per second. Cone strainers must be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the CDCR Representative. Accumulated debris must be removed through drains two inches and larger or by dropping spools and valves.

END OF SECTION
SECTION 33 40 00
STORM DRAINAGE UTILITIES

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Roadway and/or site storm drainage up to 5-feet of any on-site building.

1.2 RELATED SECTIONS
A. Section 31 23 33 – Trenching and Backfilling.

1.3 RELATED DOCUMENTS
A. AASHTO:
   1. M 252: Corrugated Polyethylene Drainage Tubing.
   2. M 294: Corrugated Polyethylene Pipe, 12 to 24-inch Diameter.
B. ASTM:
   2. A 615/A615M: Deformed and Billet-Steel Bars for Concrete Reinforcement.
   6. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   11. D 3034: Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.

C. AWWA:

3. C110: Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water.

D. Caltrans Standard Specifications:

1. Section 65, Reinforced Concrete Pipe.
2. Section 66, Corrugated Metal Pipe.
3. Section 70. Miscellaneous Facilities.
4. Section 72, Slope Protection.

E. Caltrans Standard Plans:

1. Plan D94A: Metal and Plastic Flared End Sections.
2. Plan D94B: Concrete Flared End Sections.
3. Plan D97A: Corrugated Metal Pipe Coupling Details No.1, Annular Coupling Band Bar and Strap and Angle Connection.
4. Plan D97B: Corrugated Metal Pipe Coupling Details No. 2, Hat Band Coupler and Flange Details.
5. Plan D97C: Corrugated Metal Pipe Coupling Details No. 3, Helical and Universal Couplers.
6. Plan D97D: Corrugated Metal Pipe Coupling Details No. 4, Hugger Coupling Bands.
7. Plan D97E: Corrugated Metal Pipe Coupling Details No. 5, Standard Joint.
8. Plan D97F: Corrugated Metal Pipe Coupling Details No. 6, Positive Joint.
11. Plan D98B: Slotted Corrugated Steel Pipe Drain Details.

F. California Building Code:
G. Section 1806A.11 – Pipes and Trenches.
H. Section 1133B.7.2 – Gratings.
I. California Plumbing Code.

1.4 DEFINITIONS

A. AASHTO: American Association of State Highway and Transportation Officials.
E. CMP: Corrugated metal pipe.
F. DIP: Ductile iron pipe.
G. HDPE: High-density polyethylene.
H. NPS: Nominal pipe size.
I. PE: Polyethylene.
J. PVC: Polyvinyl chloride.
K. RCP: Reinforced concrete pipe.

1.5 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.
B. Product Data Shop Drawings, Etc.: For the following:
   1. Piping materials and fittings.
   2. Special pipe couplings.
   3. Polymer-concrete, channel drainage systems (trench drains).
   4. Joint sealants.
   5. Plastic area drains.
   6. Precast concrete catch basins, inlets, curb inlets, and area drains, including frames and grates.
   7. Concrete, metal and plastic flared end sections.
C. Design Mix Reports and Calculations: For each class of cast in place concrete.
D. Field Test Reports: Indicate and interpret test results for compliance with performance.

1.6 DELIVERY, STORAGE AND HANDLING
A. Do not store plastic structures, pipe and fittings in direct sunlight.

B. Protect pipe, fittings, and seals from dirt and damage.

C. Handle precast concrete pipe and other precast structures according to manufacturer’s written instructions.

D. Protect imported bedding and backfill material from contamination by other materials.

PART 2  PRODUCTS

2.1  GENERAL

A. Products and materials listed are acceptable unless otherwise specified within the construction documents.

2.2  PIPING MATERIALS

A. Reinforced Concrete Pipe: Designated by Class, rubber gasketed joints.
   2. Oval shaped (Elliptical) Reinforced Concrete Pipe: Caltrans Standard Specification Section 65-1.02B. Class HE-III and VE-III.
   3. Reinforced Concrete Pipe Arch: Caltrans Standard Specification Section 65-1.02C.

B. PE Pipe and Fittings: 4-inch through 10-inch, AASHTO M 252 Type S, smooth interior and corrugated exterior. Bell and spigot joints.
   2. Couplings: AASHTO M 252, corrugated band type. Engage a minimum of 4 corrugations, 2 on each side of pipe joint.

C. PE Pipe and Fittings: 12-inch through 48-inch, AASHTO M 294 Type S, smooth interior and corrugated exterior. Bell and spigot joints.
   2. Couplings: AASHTO M 252, corrugated band type. Engage a minimum of 4 corrugations, 2 on each side of pipe joint.

D. PVC Pipe and Fittings-Smaller than 4-Inch: ASTM D1785, Schedule 40.
   1. Joints: Solvent Cement, ASTM D 2564. Include primer according to ASTM F656.

E. PVC Pipe and Fittings, 4-Inch and Larger
   1. Pipe:
      a. 4-inch through 15-inch: ASTM D 3034, SDR 35. Bell and spigot joints.
      b. 18 inch through 36-inch: ASTM F 679, T-1 wall. Bell and spigot joints.
2. Fittings:
   a. 4-inch through 27-inch: ASTM F 1336.
   b. 30-inch through 36-inch: ASTM D 3034, SDR 35

2.3 PIPE ANCHORS
A. Section 32 05 23 – Cement and Concrete for Exterior Improvements.

2.4 SPECIAL PIPE COUPLINGS
A. Plastic, Cast Iron and Ductile Iron Pipe: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.
B. Reinforced Concrete Pipe: Portland cement concrete collar as indicated.
C. Section 32 05 23 – Cement and Concrete for Exterior Improvements.

2.5 CURB INLETS, CATCH BASINS, DROP INLETS, AREA DRAINS, ETC.
A. General: Size, shape, configuration, depth, etc. of structure and frame, grate, or cover shall be as indicated.
B. Section 32 05 23 – Cement and Concrete for Exterior Improvements.
C. Precast Structure: Rate for AASHTO H20 loading in paved areas.
D. Steps: ASTM C 478 or AASHTO M 199. Manufacture from deformed, ½-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D4101. Include pattern designed to prevent lateral slippage off step. Acceptable manufacturer is Hanson Concrete Products, (Milpitas, CA) (Tel 408-262-1091).
E. Frames, Grates and Covers: Caltrans Standard Specification Section 75-1.02, 75-1.03 and 75-1.05.
   1. Galvanize steel frames, grates and covers.
   2. Grates and covers shall be non-rocking, bolt-down type.
   3. Rate for AASHTO H20 loading in paved areas.
   4. Provide ADA-compliant grate within pedestrian areas.

2.6 MANHOLES AND CLEANOUTS
A. See Section 33 05 16 – Utility Structures.

2.7 POLYMER-CONCRETE TRENCH DRAINS
A. General: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include number of units required to form total length required.
B. Include the following components:

1. Channel Sections: Interlocking-joint, precast modular units with end caps. Inside width as indicated with deep, rounded bottom, with built in slope or flat invert as indicated and outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.

2. Frame and Grate: Gray iron, ductile iron or galvanized steel as indicated. Where drain is located in traffic areas, rate for AASHTO H20 loading.

C. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. “Polydrain” by ABT Inc. (Troutman, NC) (Tel 704-528-9806).

2. “ACO Drain” by ACO Polymer Products Inc. (Chardon, OH) (Tel. 800-543-4764).

PART 3 EXECUTION

3.1 PIPE INSTALLATION

A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer’s instructions, and in accordance with Section 6 and 7 of ASTM D 2321 for plastic pipe, Caltrans Standard Specification Section 65-1.07 for reinforced concrete pipe, Caltrans Standard Specification Sections 66-1.045 and 66-105 for corrugated metal pipe and chapter 11.3.3 of AWWA M41 for cast iron and ductile iron pipe.

B. Pipe Depth and Trench Configuration: Conform to typical trench section(s) indicated.

C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.

D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with manufacturer’s recommendations.

E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Start laying the pipeline at the low end and proceed upstream. Lay bell and spigot pipe with the bell end facing upstream. Lay pipe on a bed prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout its entire length with bell holes provided at the ends of each pipe length of sufficient size to permit making up the particular type of joint being used. Adjust pipe to line and grade by scraping away or filling and tamping material under the body of the pipe for the entire pipe length and not by blocking or wedging. After final positioning, hold pipe in place in trench with backfill material placed equally on both sides of the pipe at as many locations as required to hold the pipe section in place.

F. Curved Alignment: When necessary to conform to the alignment specifically indicated, lay pipe on a curved alignment by means of asymmetrical closure of joints or bending of the pipe barrel. Use shorter lengths of pipe than the standard length if necessary to achieve curvature specified. Do not exceed the recommendations of the pipe manufacture for deflections at the joints or pipe bending.

G. Closure: Close open ends of pipes and appurtenance openings at the end of each day's work or when work is not in progress.
3.2 INSTALLATION OF PIPE ANCHORS
   A. Install at location, configuration and details shown on the Plans.

3.3 SPECIAL PIPE COUPLINGS
   A. General: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
   B. Installation: Per manufacturer's instructions.

3.4 INSTALLATION OF CURB INLETS, CATCH BASINS, DROP INLETS, AREA DRAINS, ETC.
   A. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.
   B. Poured in Place Structures: Install as indicated and Caltrans Standard Specification Section 51.
      1. Shape bottoms to convey flows as indicated.
   C. Precast Structures: Install as indicated.
      1. Seal all joints and pipe entrances and exits.
      2. Place concrete in bottom and shape to convey flows as indicated.

3.5 POLYMER-CONCRETE TRENCH DRAIN INSTALLATION
   A. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.
   B. Install: As indicated and in accordance with the manufacturer's instructions.

3.6 TESTING
   A. General: Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
      1. Do not enclose, cover, or put into service before inspection and approval.
      2. Test completed piping systems according to authorities having jurisdiction.
      3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
      4. Submit separate reports for each test.
      5. Where authorities having jurisdiction do not have published procedures, perform tests in accordance with latest edition of the Uniform Plumbing Code (UPC) Section 1109.0, Testing.
      6. Leaks and loss in test pressure constitute defects that must be repaired.
      7. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION
SECTION 33 46 00
SUBDRAINAGE

PART 1  GENERAL

1.1  SECTION INCLUDES

A. Subdrains in trenches and subdrains or prefabricated composite drainage panels at walls or foundations.

B. Sand-Swale filters in parking lot areas.

1.2  RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling.

B. Section 33 05 16 – Utility Structures.

C. Section 33 40 00 – Storm Drainage Utilities.

1.3  RELATED DOCUMENTS

A. AASHTO:

1. M 252: Corrugated Polyethylene Drainage Tubing.


B. ASTM:


2. D 448: Classification for Sizes of Aggregate for Road and Bridge Construction.


4. D 1785: Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.


10. D 3034: Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.


C. Caltrans Standard Specifications:
   1. Section 68-Subsurface Drains
   2. Section 88-Engineering Fabrics

1.4 DEFINITIONS

A. AASHTO: American Association of State Highway and Transportation Officials.

B. ABS: Acrylonitrile-Butadiene-Styrene.


E. HDPE: High-density polyethylene.

F. PE: Polyethylene.

G. PVC: Polyvinyl Chloride.

1.5 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – Submittal Procedures.

B. Product data for the following:
   1. Perforated pipe and fittings.
   2. Solid pipe and fittings.
   3. Prefabricated composite drainage panels.

C. Samples:
   1. Drainage Fill.

1.6 DELIVERY, STORAGE AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe-fittings, and seals from dirt and damage.

C. Protect permeable material from contamination by other materials.
PART 2   PRODUCTS

2.1    GENERAL

A. Products and materials listed are acceptable unless otherwise specified within the construction documents.

2.2    PERFORATED WALL AND SOLID WALL PIPE


B. ABS Pipe and Fittings: 4-inch through 12-inch, ASTM D 2751, SDR 35. Bell and spigot joints.

C. PE Pipe and Fittings (HDPE): 4-inch through 10-inch, AASHTO M252 Type S (Solid wall.) or SP (Perforated wall.), smooth interior and corrugated exterior. Bell and spigot joints.
   2. Couplings: AASHTO M 252, corrugated band type. Engage a minimum of 4 corrugations, 2 on each side of pipe joint.

D. PE Pipe and Fittings (HDPE): 12-inch through 48-inch, AASHTO M 294.Type S (Solid Wall.) or Type SP (Perforated wall.), smooth interior and corrugated exterior. Bell and spigot joints.
   2. Couplings: AASHTO M 252, corrugated band type. Engage a minimum of 4 corrugations, 2 on each side of pipe joint.

   1. Solvent Cement: ASTM D 2564. Include primer according to ASTM F656.

F. PVC Pipe and Fittings:
   3. Fittings: ASTM F 1336.
2.3 SPECIAL PIPE COUPLINGS

A. Description: ASTM C 1173. Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.

2.4 CLEANOUTS

A. See 33 05 16 – Utility Structures.

2.5 PREFabricated COMPOSITE DRAINAGE PANELs

A. Description: Prefabricated composite panels, 36 to 60-inches wide and manufactured with geotextile facing laminated to molded drainage core.

B. Drainage Core: Three-dimensional, non-biodegradable, molded Polypropylene or Polystyrene.
   1. Minimum Compressive Strength: 10,000-lbf./sq. ft. when tested according to ASTM D 1621.
   2. Minimum Flow Rate: 7 gpm per foot at hydraulic gradient of 0.1 and compressive stress of 25 psig when tested according to ASTM D 4716.

C. Geotextile: Non-woven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288.
   1. Survivability Class: 2.
   2. Apparent Opening Size: No. 60 sieve maximum.
   3. Permittivity: 0.2 per second, minimum.

D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:
   1. American Wick Drain Corporation (Matthews, NC).
   2. Mirafi Inc. (Charlotte, NC) (Tel. 800-438-1855).
   4. Phillips Fibers Corporation (Greenville, SC) (Tel. 800-845-5737).

2.6 DRAINAGE FILL MATERIAL

   1. Class 2

B. Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448, coarse aggregate, Sieve No. 57, with 100 percent passing 1-1/2-inch sieve and not more than 5 percent passing No. 8 sieve.


2.7 FILTER FABRIC

A. When required, use filter fabric for encasing permeable material around subdrains.

2. Mirafi 140N (Mirafi Inc., Charlotte, NC) (Tel. 800-438-1855) or equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. Install only after unsatisfactory conditions have been corrected.

3.2 PIPING APPLICATIONS

A. Refer to Plans for location, size, and material designation for individual subdrains.

3.3 INSTALLATION OF PERFORATED PORTIONS OF SUBDRAINS

A. Excavation: Section 6 of ASTM D 2321 and as indicated.

B. Subdrain Bedding: Place supporting layer of drainage fill over compacted subgrade to compacted depth indicated. If drainage fill requires encasement in filter fabric, lay filter fabric in trench and overlap trench sides before installing drainage fill.

C. Piping Installation: Install pipe in accordance with Section 7 of ASTM D 2321. Install piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert. Excavate recesses for bottoms of bell ends of pipe. Lay pipe with bells facing upslope and with spigot end centered fully into adjacent bell. Bed piping with full pipe bearing in drainage fill material. Lay perforated pipe with perforations down. Install gaskets, seals, sleeves, and couplings in accordance with manufacturers written instructions. Use increasers, reducers, and couplings made for different sizes of materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

D. Initial Subdrain Backfill: After installing drainage piping, add drainage fill up to top of pipe to perform tests.

E. Testing Subdrain: After installing drainage fill to top of pipe, test drain piping with water to ensure free flow before backfilling with drainage fill. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

F. Subsequent Subdrain Backfill: After satisfactory testing, cover piping with drainage fill to width and height indicated. Place drainage fill in layers not exceeding 3 inches in loose depth; compact each layer placed. If filter fabric is required complete the filter fabric encasement by bringing fabric to top and closing the encasement.

G. Fill to Grade: Place native fill material over compacted drain fill to thickness indicated. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish elevations unless otherwise specified on the plans.

3.4 INSTALLATION OF NON-PERFORATED PORTIONS OF SUBDRAINS

A. Conform to Section 31 23 33 – Trenching and Backfilling, and Section 33 46 00 – Storm Drainage Utilities.
3.5 PREFabricated COMPOSITE DRAINAGE PANELS

A. Coordinate placement with other drainage materials.
B. Install prefabricated drainage panels in accordance with manufacturer's instructions.
C. Place perforated drainage pipe at base of footing and attach to composite drainage panels in accordance with the manufacturer's instructions.

3.6 JOINING PIPE

A. Join ABS and PVC pipe and fittings with elastomeric seals according to ASTM D 2321 or solvent cement.
B. Special pipe couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and that fit both pipe materials and dimensions.

3.7 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION
DIVISIONS 34 – 49
NOT USED