

BD 2016 - 00431

County of San Mateo Serenity House

3701 Hacienda Street
San Mateo, CA 94403

**JOB COPY
TO REMAIN ON
SITE AT ALL TIMES**

**APPROVED PLAN
SEP 30 2016**

**BY
SAN MATEO COUNTY BUILDING
INSPECTION DIVISION**

Project Manual

Construction Documents and reference materials for Remodel of existing county facilities Construction Document Bid Set Volume 3



Architecture | Engineering | Planning

Hammel, Green and Abrahamson, Inc.
Architects and Engineers
170 Maiden Lane, 5th Floor
San Francisco, California 94108

(415) 814-6910

HGA COMMISSION NUMBER

3505-003-01

REVISION

SEP 06 2016

**San Mateo County
Building Inspection**

February 5, 2016

February 5, 2016

000110
TABLE OF CONTENTS

1 New Section, August 26, 2016

VOLUME 1

000110 Table of Contents

DIVISION 00 PROCUREMENT AND CONTRACTING REQUIREMENTS

County of San Mateo, State of California Project Manual and Construction Documents
Title Sheet
Index
Project Directory
Notice To Contractors
Instruction To Bidders
General Conditions
Supplemental General Conditions
Equal Benefits Ordinance
Jury Service Ordinance
Recycling Ordinance
Special Provisions
Proposal
Non Collusion Declaration
Bid Bond
Equal Employment Opportunity Program
Certificate of Compliance
Equal Employment Opportunity Program Report Form
Contractor's Declaration Form
Anti-Trust
Agreement
Payment Bond
Performance Bond
Guarantee Form
Waste Management Plan
Furniture, Fixtures and Equipment Schedule

VOLUME 2

000105.12 Certifications Page - CA
000110 Table of Contents

DIVISION 01 GENERAL REQUIREMENTS

010000 General Requirements
013310 Submittal Transmittal
016211 Substitution Request Form

DIVISION 02 EXISTING CONDITIONS

024000 Demolition
024119 Selective Demolition

DIVISION 03 CONCRETE

031500 Concrete Accessories
033000 Cast-In-Place Concrete

DIVISION 04 MASONRY

Not Used

DIVISION 05 METALS

057005 Landscape Metalwork

DIVISION 06 WOOD, PLASTICS, AND COMPOSITES

061000 Rough Carpentry
062010 Site Carpentry
064000 Architectural Woodwork

DIVISION 07 THERMAL AND MOISTURE PROTECTION

075113 Built-Up Asphalt Roofing
075713 Polyurethane Foam Roofing
076000 Flashing and Sheet Metal
076100 Sheet Metal Roofing
077200 Roof Accessories
079000 Joint Protection

CO
1

DIVISION 08 OPENINGS

081400 Wood Doors
085213 Metal-Clad Wood Windows
087100 Door Hardware
088000 Glazing

DIVISION 09 FINISHES

092400 Portland Cement Plastering
092900 Gypsum Board
093000 Tiling
096500 Resilient Flooring
099000 Painting

DIVISION 10 SPECIALTIES

101420 Interior Door and Room Signage
102813 Toilet Accessories
104400 Fire Protection Specialties

DIVISION 11 EQUIPMENT

113100 Residential Appliances

DIVISION 12 FURNISHINGS

122413 Window Shades
129300 Site Furnishings

DIVISION 13 SPECIAL CONSTRUCTION

Not Used

DIVISION 14 CONVEYING EQUIPMENT

144200 Wheelchair Lifts

DIVISION 15 THROUGH 20

Not Used

VOLUME 3

000110 Table of Contents

DIVISION 21 FIRE SUPPRESSION

210000 Fire Suppression Basic Requirements
210500 Common Work Results for Fire Suppression
211300 Fire Suppression Sprinkler Systems

DIVISION 22 PLUMBING

220000 Plumbing Basic Requirements
220516 Expansion Fittings and Loops for Plumbing Piping
220519 Plumbing Devices

220523	General-Duty Valves for Plumbing Piping
220529	Hangers and Supports for Plumbing Piping and Equipment
220548	Vibration and Seismic Controls for Plumbing Piping and Equipment
220553	Identification for Plumbing Piping and Equipment
220593	Testing, Adjusting, and Balancing for Plumbing
220700	Plumbing Insulation
221000	Plumbing Piping
223000	Plumbing Equipment
224000	Plumbing Fixtures

1

DIVISION 23 HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

230000	Heating, Ventilating and Air Conditioning (HVAC) Basic Requirements
230519	Meters and Gauges for HVAC Piping
230523	General-Duty Valves for HVAC Piping
230529	Hangers and Supports for HVAC Piping, Ductwork and Equipment
230548	Vibration and Seismic Controls for HVAC Equipment
230553	Identification for HVAC Piping, Ductwork and Equipment
230593	Testing, Adjusting, and Balancing for HVAC
230700	HVAC Insulation
230933	Electric and Electronic Control System for HVAC
232113	HVAC Piping
233100	HVAC Ducts and Casings
233300	Air Duct Accessories
233400	HVAC FANS
233500	Refrigeration Detection and Alarm
233700	Air Outlets and Inlets
234000	HVAC Air Cleaning Devices
235100	Breechings, Chimney and Stacks
235500	Fuel Fired Heaters
238126	Small Split System and Unitary HVAC Equipment
238216	Air Coils

1

DIVISION 24 THROUGH 25

Not Used

DIVISION 26 ELECTRICAL

260000	Electrical Basic Requirements
260509	Equipment Wiring
260519	Low-Voltage Electrical Power Conductors and Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems and Equipment
260533	Raceways
260534	Boxes
260553	Identification for Electrical Systems
260573	Electrical Distribution System Studies
260920	Lighting Relay Control Panel
260923	Occupancy/Vacancy Sensors
260924	Daylighting Controls
262416	Panelboards
262713	Electrical Metering
262716	Electrical Cabinets and Enclosures
262726	Wiring Devices
262800	Overcurrent Protective Devices
262816	Enclosed Switches and Circuit Breakers
265100	Lighting

1

1

1

DIVISION 27 COMMUNICATIONS

270000	Communications Basic Requirements
270528	Pathways for Communications Systems

275320 Cable Television Distribution System

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

280001 Electronic Safety Basic Requirements
283100 Fire Detection and Alarm

DIVISION 29 THROUGH 30

Not Used

DIVISION 31 EARTHWORK

311001 Plant Protection
311100 Clearing and Grubbing
311300 Selective Tree Removal and Trimming
311400 Earth Stripping and Stockpiling
312300 Excavation and Fill
312333 Trenching and Backfilling
313119 Vegetation Control

DIVISION 32 EXTERIOR IMPROVEMENTS

320513 Soil for Bioretention Facilities
320523 Cement and Concrete for Exterior Improvements
321100 Base Courses
321200 Flexible Paving
321320 Site Concrete
321545 Stabilized Decomposed Granite Paving
321613 Concrete Curbs and Gutters
321713 Parking Bumpers
321723 Pavement Markings
321726 Tactile Warning Surfaces
311813 Synthetic Turf System
323116 Ornamental Fences & Gates
323119 Chain Link Fencing
323233 Stone Walls
328400 Irrigation
329000 Planting



DIVISION 33 UTILITIES

330516 Utility Structures
334000 Storm Drainage
334600 Subdrainage

END OF SECTION

**SECTION 210000
FIRE SUPPRESSION BASIC REQUIREMENTS**

PART 1 - GENERAL

1.1 DESIGN-BUILD SUMMARY OF WORK

- A. Work Included: Work included in 21 00 00 applies to Division 21, Fire Suppression work to provide materials, labor, tools, permits and incidentals to make fire suppression systems ready for Owner's use for proposed project.

1.2 DESIGN-BUILD INSTRUCTIONS

- A. This document is issued to give Bidders a basis for preparing a proposal to design and install a complete Fire Suppression system for this project.
- B. Alternates to this Document may be offered as a separate proposal.

1.3 DESIGN-BUILD DESIGN APPROACH

- A. Use this Specification as a guide for design/engineering requirements, workmanship and materials or construction. Utilize design-build concept throughout construction phase of project.
- B. Investigate and be apprised of applicable codes, rules and regulations as enforced by AHJ.
- C. Visit the Site of the proposed construction. Verify and inspect the existing site to determine conditions that affect this work.

1.4 DESIGN-BUILD DESIGN CRITERIA/CALCULATIONS

- A. Related Work Specified Elsewhere:
 - 1. Contents of Section apply to Division 21, Fire Suppression Specifications.
 - 2. Requirements of Section are a minimum for Division 21, Fire Suppression Sections, unless otherwise stated in each Section, in which case that Section's requirements take precedence.
- B. Fire Suppression Design Criteria: Refer to individual Division 21, Fire Suppression Sections for fire suppression system design criteria.
- C. Fire Suppression Equipment: Refer to individual Division 21, Fire Suppression Sections for fire suppression equipment requirements.

1.5 SECTION INCLUDES

- A. Work included in 21 00 00, Fire Suppression Basic Requirements applies to Division 21, Fire Suppression work to provide materials, labor, tools, permits, incidentals and other services to provide and make ready for Owner's use of fire protection systems for proposed project.
- B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. Definitions:
 - 1. Provide: To furnish and install, complete and ready for intended use.
 - 2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
 - 3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete Item of work furnished.

4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent," substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements and approved by the Engineer prior to submitting bids for substituted Item.
5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative and other reviewing entity whose approval is required to obtain systems acceptance.

1.6 RELATED SECTIONS:

- A. Content of Section applies to Division 21, Fire Suppression Contract Documents.
- B. Related Work:
 1. Additional conditions apply to this Division including, but not limited to:
 - a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - b. Drawings
 - c. Addenda
 - d. Owner/Architect Agreement
 - e. Owner/Contractor Agreement
 - f. Codes, Standards, Public Ordinances and Permits

1.7 REFERENCES AND STANDARDS

- A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 21, Fire Suppression Sections and those listed in this Section.
- B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 1. State of California:
 - a. CBC California Building Code
 - b. CEC California Electrical Code
 - c. CEC T24 California Energy Code Title 24
 - d. CFC California Fire Code
 - e. CMC California Mechanical Code
 - f. CPC California Plumbing Code
 - g. CSFM California State Fire Marshal
 - h. DSA Division of State Architect Regulations and Requirements
- C. Reference standards and guidelines include but are not limited to the latest adopted editions from:
 1. ABA Architectural Barriers Act
 2. ADA Americans with Disabilities Act
 3. AHRI Air-Conditioning Heating & Refrigeration Institute
 4. ANSI American National Standards Institute
 5. ASCE American Society of Civil Engineers
 6. ASCE-7 ASCE-7 Minimum Design Loads for Buildings and Other Structures
 7. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
 8. ASHRAE Guideline 0, the Commissioning Process
 9. ASME American Society of Mechanical Engineers
 10. ASPE American Society of Plumbing Engineers
 11. ASSE American Society of Sanitary Engineering
 12. ASTM ASTM International
 13. AWWA American Water Works Association

14. CFR	Code of Federal Regulations
15. CSA	CSA International
16. EPA	Environmental Protection Agency
17. ETL	Electrical Testing Laboratories
18. FCC	Federal Communications Commission
19. FDA	Food & Drug Administration
20. FM	FM Global
21. FM Global	FM Global Approval Guide
22. IAPMO	International Association of Plumbing and Mechanical Officials
23. ICC	International Code Council
24. IEC	International Electrotechnical Commission
25. ICC-ESR	International Code Council Evaluation Service Reports
26. HI	Hydraulic Institute Standards
27. ISO	International Organization for Standardization
28. LEED	Leadership in Energy and Environmental Design
29. MSS	Manufacturers Standardization Society
30. NEC	National Electric Code
31. NEMA	National Electrical Manufacturers Association
32. NFPA	National Fire Protection Association:
a. NFPA 13	Standard for the Installation of Sprinkler Systems
b. NFPA 25	Standard for Inspection, Testing and Maintenance of Water-Based
c. NFPA 70	National Electrical Code
d. NFPA 72	National Fire Alarm and Signaling Code
33. NRCA	National Roofing Contractors Association
34. NSF	National Sanitation Foundation
35. OSHA	Occupational Safety and Health Administration
36. SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
37. TIMA	Thermal Insulation Manufacturers Association
38. UL	Underwriters Laboratories Inc.
39. USDA	United States Department of Agriculture

- D. See Division 21, Fire Suppression individual Sections for additional references.
- E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.
- F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.
- G. Piping Insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.8 SUBMITTALS

- A. See Division 01, General Requirements for Submittal Procedures as well as specific individual Division 21, Fire Suppression sections.
- B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:

1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades and the satisfactory performance of the work.
2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
3. General: Submit shop drawings, calculations and product data sheets as one complete stand-alone package to AHJ, Owner's insurance underwriter and Engineer.
4. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 21, Fire Suppression Sections.
5. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
 - a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed Item. Highlight connections by/to other trades.
 - b. Include technical data, installation instructions and dimensioned drawings for products, equipment and devices installed, furnished or provided. Reference Division 21, Fire Suppression specification Sections for specific Item required in product data submittal outside of these requirements.
 - c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
 - d. For vibration isolation of equipment, list make and model selected with operating load and deflection. Indicate frame type where required. Submit manufacturer's product data.
 - e. See Division 21, Fire Suppression Sections for additional submittal requirements outside of these requirements.
6. Maximum of two reviews provided of complete submittal package. Arrange for additional reviews and/or early review of long-lead Item; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
8. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams and connections as required per Division 21, Fire Suppression coordination documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical and Division 28, Electronic Security submittals.
9. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
10. Substitutions and Variation from Basis of Design:
 - a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
 - b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in and furnishing the substitute and/or

equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

11. Shop Drawings:

- a. Provide coordinated Shop Drawings which include physical characteristics of all systems, equipment and piping layout, pipe layout, hanger layout, sway brace layout, seismic restraints, sway brace calculations, drains, location of drain discharge, risers, valves, details, water test information, physical device layout plans and control wiring diagrams. Reference individual Division 21, Fire Suppression Sections for additional requirements for shop drawings outside of these requirements.
- b. Shop Drawings and hydraulics calculations, sway brace calculations, trapeze hanger calculations and the like, to be prepared under the direct supervision and control of a Professional Engineer competent to do such work and licensed in the state of California. Drawings and calculations to bear the seal and wet signature of the professional Engineer.
- c. Provide Shop Drawings which indicate information required by NFPA 13. Include room names and fire sprinkler occupancy hazard classifications.
- d. Provide Shop Drawings illustrating information for Hydraulic Information Sign for each hydraulic remote area calculated.
- e. Utilizing the Reflected Ceiling backgrounds, provide Shop Drawings illustrating locations of fire sprinklers and piping.
- f. Utilizing the Structural backgrounds, provide Shop Drawings illustrating locations and types of hangers and sway braces.
- g. Provide Shop Drawings illustrating each type of hanger, including fasteners to structure.
- h. Provide Shop Drawings illustrating each type of branchline restraint and sway brace, including length of sway brace member, sway brace fittings, minimum and maximum angles from vertical of sway brace member, method of attachment to structure, size, length and embedment of attachment to structure and size and type of structural member to which sway brace will be attached. Number each type of restraint and sway brace. Indicate on Drawings locations of each type of numbered restraint and sway brace.
- i. Provide Shop Drawings illustrating information for Sprinkler System General Information Sign.
- j. Shop Drawings to include a cross-Sectional view that shows the sprinkler heads and piping in relation to the building's architectural and structural information. View to be chosen based on a location that will display the most information.
- k. When required, provide Coordination Drawings.
- l. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
- m. Provide details of hanger, sway bracing and branch line restraint attachments to structure and to piping. Include details on the size and load capacities of fasteners. Provide verification of the structural capacity to withstand seismic load.
- n. Provide sway bracing calculations on drawings showing horizontal seismic design load and requirements, with indication of zone of influence for each bracing location.
- o. Provide a schedule of sway bracing type, size and design criteria, including length, angle from vertical and load capacities.
- p. Clearly indicate the elevation of the highest sprinkler in relation to the elevation of the flow test pressure gauge monitor hydrant.
- q. Provide details of flexible branch line connectors per manufacturer's schedule of equivalent feet used in hydraulic calculations, showing connector device length, maximum number of 90-degree bends and expected radius of bends.

12. Samples: Provide samples when requested by individual Sections.

13. Resubmission Requirements:

- a. Make any corrections or change in submittals when required. Provide submittals as specified. The Engineer will not be required to edit and/or interpret the Contractor's

submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Clearly indicate changes on Drawings and cloud changes in the submittals.

- b. Resubmit for review until review indicates no exceptions taken or make "corrections as noted".

14. Operation and Maintenance Manuals/Owners Instructions:

- a. Submit, at one time, one bound copy and electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or Item requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
 - 1) Include copies of certificates of code authority acceptance, code-required acceptance tests; test reports and certificates.
 - 2) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Sections.
 - 3) Catalog description of each Item of equipment actually installed on job.
 - 4) Instructions for operation and maintenance of fire suppression systems composed of operating instructions, maintenance instructions and manufacturer's literature as follows:
 - (a) Testing and Maintenance Schedule Chart: Provide an 8-1/2- by 11-inch typewritten list of each item of installed equipment requiring testing inspection, lubrication or service, describing and scheduling performance of maintenance.
 - (b) Manufacturer's Literature: Provide copies of manufacturer's instructions for operation and maintenance of fire suppression equipment, including replacement parts list with name and address of nearest distributor. Mark each copy with equipment identification label as listed in equipment schedule, i.e. F-5 etc.
 - 5) Include product certificates of warranties and guarantees.
 - 6) Include Record Drawings,
 - 7) Include copy of water supply flow test used as basis for hydraulic calculations.
 - 8) Include hydraulic calculations and sway brace calculations.
 - 9) Include Contractor's Material and Test Certificates for Aboveground Piping/Underground Piping.
 - 10) Include a copy of NFPA 25.
 - 11) Include a copy of valve charts and whether normally open or normally closed.
 - 12) Include a copy of drain, auxiliary and low point drains charts.
 - 13) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
 - 14) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes and quantities relevant to each piece of equipment: i.e. belts, motors, lubricants and filters.
 - 15) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub-assemblies.
 - 16) Include copy of startup and test reports specific to each piece of equipment.
 - 17) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
- b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 21 00 00, Fire Suppression Basic Requirements, Article titled "Demonstration".
- c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

15. Record Drawings:
 - a. Maintain at site at least one set of Drawings for recording "As-constructed" conditions. Indicate on Drawings changes to original documents by referencing revision document and include buried elements, location of cleanouts and location of concealed mechanical Item. Include items changed by field orders, supplemental instructions and constructed conditions.
 - b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
 - c. At completion of project, input changes to original project on CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
 - d. Invert elevations and dimensioned locations for water services and drainage piping below grade extending to 5-feet outside building line.
 - e. Record Drawings to include site information or reference site information for complete understanding of the fire protection system between the building and the point of connection to the water supply and location of flow test pressure hydrants.
 - f. See Division 21, Fire Suppression individual Sections for additional items to include in Record Drawings.
16. Calculations: Submit hydraulic and sway brace and the like calculations.
 - a. Hydraulic Calculations:
 - 1) Include friction losses between the hydraulically most remote design area and the hydrant flow test pressure hydrant.
 - 2) Hydraulic calculations to be performed on a nationally recognized fire sprinkler hydraulic calculation computer program, with cover sheets in the format required by the latest edition of NFPA 13. Hydraulic calculations performed "by hand" or not on a nationally recognized fire sprinkler hydraulic calculations computer program will be returned without review by engineer.
 - 3) Provide one or more hydraulic calculations for each hydraulically most remote area.
 - 4) Where it is not obvious which area is most hydraulically remote, perform and submit for review additional hydraulic calculations proving the hydraulically most remote area.
 - 5) For grid systems, either provide "peaked" hydraulic calculations, or provide two additional sets of hydraulic calculations for each hydraulically most remote area.
 - 6) Include pressure losses between the highest sprinkler and the elevation of the pressure gauge monitor hydrant of the flow test.
 - 7) Include friction loss for flexible branch line connectors per manufacturer's schedule of equivalent feet for device length, maximum number of bends and expected radius of bends.
 - b. Sway Brace Calculations: Sway brace calculations utilizing a proprietary computer calculation program only used for the sway brace components supported by that manufacturer. For example, only "manufacturer X" sway brace components and not those of another manufacturer, may be calculated on a "manufacturer X" sway brace computer calculation program.

1.9 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed to conform with all local, State, Federal and other applicable laws and regulations.
- B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every Item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler and plumbing systems.
- C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

- D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- E. Provide products which are UL listed.

1.10 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.11 COORDINATION DOCUMENTS

- A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, fire alarm, plumbing, cable trays, lights and electrical services with architectural and structural requirements and other trades (including fire alarm ceiling suspension and tile systems) and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling and finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
- B. Advise Architect in the event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
- C. Verify in field exact size, location, invert and clearances regarding existing material, equipment and apparatus and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation.
- D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide like Item from one manufacturer, including but not limited to sprinkler heads, pipe, fittings, hangers and bracing materials.

2.2 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL, ETL, FM, and ICC-ES approved for their intended fire protection function or have adequate approval or be acceptable by State, County and City authorities.
- B. Articles, fixtures and equipment of a kind to be standard product of one manufacturer.
- C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- D. Hazardous Materials:
 - 1. Comply with local, State of California, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.

3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 21, Fire Suppression Sections. In absence of specific requirements, provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
 1. Ceiling access panels to be minimum of 24-inch by 24-inch required and approved size.
 2. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
 3. Provide two keys for each set of keyed cylinder type locks.
 4. Manufacturers and Models:
 - a. Drywall: Karp KDW.
 - b. Plaster: Karp DSC-214PL.
 - c. Masonry: Karp DSC-214M.
 - d. 2 hour rated: Karp KPF-350FR.
 - e. Manufacturers: Karp, Milcor, Elmdor, Acudor or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Install equipment requiring access (i.e. drains, control operators, valves, motors, engines, pumps, controllers, air compressors, gauges, fill cups, tanks, cleanouts and the like) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.
- C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.
- D. Earthwork: Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with the following:
 1. Perform excavation, dewatering, shoring, bedding and backfill required for installation of work in this Division in accordance with the provisions specified. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
 2. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
 3. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.
- E. Firestopping: Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and coordinate location and protection level of fire and/or smoke rated walls, ceilings and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with

approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM International E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Pipe Installation:

1. Coordinate work to account for expansion and contraction of piping materials and building as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment and building and its contents. Provide piping offsets, loops, expansion joints, sleeves, anchors or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products and rating coordinating installation of piping systems.
2. Include provisions for servicing and removal of equipment without dismantling piping.

G. Plenums: Provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

3.2 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Equipment Importance Factor: 1.5.

C. Confirm Building Risk Category and Seismic Design Category with Architect.

D. Provide fire suppression equipment and piping, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight or lateral seismic forces as determined by building code and NFPA 13 calculations, whichever is more demanding.

E. Earthquake resistant designs for Fire Protection (Division 21, Fire Suppression) equipment and distribution, i.e. fire sprinkler systems, fire standpipe systems, fire pumps, fire pump controllers, fire tanks, clean agent fire suppression systems, etc. conform to regulations of jurisdiction having authority.

F. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.

G. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping, equipment, tanks, pumps controllers and the like. Submit shop drawings along with equipment submittals.

H. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.

I. Provide details of flexible drops for sprinklers in conformance with Building Code and ASCE 7 requirements of ceilings. Coordinate with Architectural and Structural Drawings and Specifications.

J. Piping: Per NFPA 13, ASCE-7 and local requirements.

K. Equipment: Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA, ASCE 7 and local requirements. Provide means to prohibit excessive motion of fire protection equipment during an earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
 - 1. Underground piping installation prior to backfilling.
 - 2. Prior to covering walls.
 - 3. Prior to ceiling cover/installation.
 - 4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
 - 5. When mains or branchlines are to be permanently concealed by construction or insulation systems.
 - 6. When fire suppression systems, or portions of, are being tested and ready for inspection by AHJ.
- C. Bear responsibility and cost to make piping accessible, to expose concealed lines, or to demonstrate acceptability of the system. If Contractor fails to notify Architect at times prescribed above, costs incurred by removal of such work are the responsibility of the Contractor.
- D. Final Punch: Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.4 CONTINUITY OF SERVICE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
 - 1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
 - 2. Prior to changing over to new service, verify that every Item is thoroughly prepared. Install new piping and wiring to point of connection.
 - 3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference at a minimum. If overtime is required, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 - 4. During entire time system, or part thereof, is not operational, provide a firewatch per Fire Code, including a watchperson whose sole duty is to watch for and report fires.
 - 5. Organize work to minimize duration of power interruption.

3.5 CUTTING AND PATCHING

- A. Confirm Cutting and Patching requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
 - 1. Cutting and patching performed under Division 21, Fire Suppression includes, but is not limited to:
 - a. Cutting and patching of plaster or partitions.
 - b. Cutting and patching of finished ceilings.
 - 2. Perform cutting and patching by skilled craftsmen in trade of work to be performed. Fill holes which are cut oversized for completed work. Match refinished areas with existing adjacent finish in a manner acceptable to Architect.
 - 3. When masonry to concrete construction must be penetrated, provide a steel pipe sleeve in opening and grout in place in a neat manner. Leave grout surface to match existing finish. Provide escutcheons. If sleeves are not provided, core drill penetrations.

4. Locate concealed utilities to eliminate possible service interruption or damage.
5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.
6. Proposed floor cutting/core drilling/sleeve locations to be approved by project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
7. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
8. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
9. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, landscaping, paving and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
10. Repair mutilation of building around pipes, equipment, hangers and braces.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

- A. Replace or reposition equipment which is too large or located incorrectly to permit servicing at no additional cost to Owner.

3.7 DELIVERY, STORAGE AND HANDLING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
 1. Handle materials delivered to project site with care to avoid damage and deterioration. Store materials in original containers which identify manufacturer, name, brand and model numbers on site inside building or protected from weather, sun, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.
 2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
 3. Protect bright finished shafts, bearing housings and similar Item until in service.

3.8 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner to instruct maintenance personnel, correct defects or deficiencies and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of

other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

- D. Prior to acceptance of work and during time designated by Architect, provide necessary qualified personnel to operate system for a period of two hours.
- E. Instruct the Owner in the operation of the sprinkler system, including main valve position (open or closed) recognition, system drainage, system testing, dry pipe valve reset and the relation to the fire alarm system.
- F. Upon completion of work and adjustment of equipment, test systems to demonstrate to Owner's Representative and Architect that equipment is furnished and installed or connected under provisions of these Specifications.

3.9 CLEANING

- A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Upon completion of installation, except for sprinklers, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.
- C. Sprinklers may not be cleaned except for vacuuming in a manner in which no part of the sprinkler is touched by the vacuuming equipment. Replace sprinklers which bear traces of foreign substances with sprinklers of same model, temperature, K-factor, orifice, finish, style, orientation and the like.

3.10 INSTALLATION

- A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Install equipment in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.
- C. Start-up equipment, in accordance with manufacturer's start-up instructions, in the presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment. Provide pump impellers to obtain Basis of Design design capacities.
- D. Provide miscellaneous supports/metals required for installation of equipment and piping.

3.11 PAINTING

- A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
 - 1. Ferrous Metal: After completion of fire protection work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
 - 2. After acceptance by AHJ, in a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
 - 3. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

4. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.
5. Covers: Covers such as vault covers and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

- A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and coordinate locations/sizes of access panels with Architect prior to work. Label access panels with engraved nameplates indicating function of panel.

3.13 DEMOLITION

- A. Confirm Demolition requirements in Division 01, General Requirements and Division 02, Existing Conditions. In absence of specific requirements, comply with individual Sections in Division 21, Fire Suppression and the following:
 1. Scope:
 - a. It is the intent of these documents to provide necessary information and adjustments to fire protection system required to meet code and accommodate installation of new work.
 - b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
 - c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged Item with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
 2. Equipment and Piping: Unless otherwise directed, equipment, piping, or fittings being removed as part of demolition process are Owner's property. Remove other Item not scheduled to be reused or relocated from job site as directed by Owner.
 3. Unless specifically indicated on Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.
 4. Unless specifically indicated on Drawings, remove unused equipment, fittings, rough-ins and connectors. Removal is to be to a point behind finished surfaces (floors, walls and ceilings).
 5. Coordinate demolition of existing fire suppression systems with Contractor. Where applicable or possible, portions of fire suppression demolition work may be performed by Contractor. Verify with local AHJ as to limitations of demolition by others and not fire suppression trades. Coordinate extent of demolition of fire suppression work to be done by others and supervise this work. No extra costs will be approved by replacement of systems due to improper or excessive demolition.

3.14 ACCEPTANCE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Sections in Division 21, Fire Suppression and the following:
 1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
 - a. Testing reports including Contractor's Material and Test Certificate for Underground Piping, Contractor's Material and Test Certificate for Aboveground Piping, Contractor's Material and Test Certificate for Private Fire Service Mains, Fire pump acceptance test data report and the like.
 - b. Cleaning
 - c. Operation and Maintenance Manuals
 - d. Training of Operating Personnel
 - e. Record Drawings
 - f. Warranty and Guaranty Certificates

- g. Start-up/Test Document and Commissioning Reports
- h. Letter of Conformance

3.15 FIELD QUALITY CONTROL

- A. Confirm Field Quality Control requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Upon completion of installation of equipment, sprinklers, hose valves and piping and after units are water pressurized, test system to demonstrate capability and compliance with requirements. When possible, correct malfunctioning Item at site, then retest to demonstrate compliance; otherwise remove and replace with new Item and proceed with retesting.
- C. Inspect each installed Item for damage to finish. If feasible, restore and match finish to original, except fire sprinklers, at site; otherwise, remove Item and replace with new Item Feasibility and match to be judged by Architect. Remove cracked or dented Item and replace with new Item.
- D. Fire sprinklers may not be reused, or cleaned, except for dusting. Replace damaged, field painted, oversprayed, overcoated or field coated sprinklers with new sprinklers of same manufacturer, model, finish, K-factor and performance characteristics. Where identical replacement sprinklers are not available, provide sprinklers of similar finish, style, K-factor and performance characteristics.

3.16 ELECTRICAL INTERLOCKS

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

3.17 CONNECTIONS TO EXISTING

- A. Prior to connection of piping to existing piping or utilities, field verify existing conditions and exact sizes and locations of existing piping. Provide additional offsets, transitions, joints, cut-ins and replace portions of existing as required to facilitate connections of new.

END OF SECTION

**SECTION 210500
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
1. Aboveground Black Steel Pipe and Fittings
 2. Aboveground Galvanized Steel Pipe and Fittings
 3. Wall and Floor Penetrations and Sleeves
 4. Hangers and Supports
 5. Struts and Strut Clamps
 6. Sway Braces and Restraints
 7. Anchors and Attachments
 8. Bells
 9. Pipe Valve and Fire Protection Equipment Identification
 10. Signs
 11. Drains

1.2 RELATED SECTIONS

- A. Contents of Division 21, Fire Suppression and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
1. Division 22, Plumbing
 2. Division 23, Heating, Ventilating and Air Conditioning
 3. Division 26, Electrical
 4. Division 28, Electronic Security
 5. Section 21 00 00, Fire Suppression Basic Requirements
 6. Section 21 13 00, Fire Suppression Sprinkler Systems

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.
- B. Meet requirements of ASCE 7, Minimum Design Loads for Buildings and Other Structures, by American Society of Civil Engineers, latest adopted edition.

1.4 SUBMITTALS

- A. Submittals as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.
- B. Provide seismic calculations for any sway brace to be attached to any I-joint according to the specifications of the I-joint manufacturer.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:

1. Material and Equipment: Listed for its intended fire protection use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, International Code Council Evaluation Service Reports, California State Fire Marshal's Building Materials Listing Program or FM Global Approval Guide, new and of current manufacture.
2. Provide per AHJ requirements.
3. References to product Specifications for materials are listed according to accepted ANSI, ASTM, ASME, AWWA and other base standards. Materials to meet latest approved versions of these standards.
4. See Section 21 00 00, Fire Suppression Basic Requirements where piping materials are approved for use.
5. Fire Suppression Screw-Thread Connections: Comply with local fire department/fire marshal regulations for sizes, threading and arrangement of connections for fire department equipment to fire department connections.
6. Manufacturers: Unless an item is marked "No substitutions", submit substitution request for materials of other than named manufacturers.
7. Noise and Vibration:
 - a. Install vibration isolators and measures required to prevent noise and vibration from being transmitted to occupied areas. Select equipment to operate within noise coefficient (NC) design level for particular type of installation in relation to its location.
 - b. After installation, make proper adjustments to reduce noise and vibration to acceptable levels as defined by Architect.
 - c. In acoustically sensitive areas, design system in a manner that minimizes the number of wall penetrations.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.7 FLOW TEST

1.8 SYSTEM IMPAIRMENT

- A. When returning a water-based fire protection system to service after impairment or control valve closure, verify the system is in working order by performing a main drain test per NFPA 25.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Aboveground Black Steel Pipe and Fittings:
 1. Pipe:
 - a. Allied Tube & Conduit Corporation
 - b. Bull Moose Tube
 - c. Wheatland Tube Company
 - d. Youngstown Tube Company
 - e. Tex-Tube Company
 - f. State Pipe and Supply, Incorporated
 - g. Or approved equivalent
 2. Fittings, Mechanical and Grooved Couplings:
 - a. Gruvlok
 - b. Victaulic
 - c. Shurjoint Piping Products Incorporated
 - d. Smith-Cooper International
 - e. Tyco Fire & Building Products
 - f. Viking Corporation
 - g. Allied Rubber and Gasket Company Incorporated, dba ARGCO

- h. Anvil International
 - i. Dixon Valve & Coupling
 - j. Or approved equivalent.
3. Fittings, Threaded:
- a. Ward Manufacturing
 - b. Anvil International
 - c. Smith-Cooper International
 - d. Aegis Technologies
 - e. Or approved equivalent.
4. Fittings, Rubber Gasketed:
- a. Anvil International
 - b. AnvilStar
 - c. EBAA Iron, Incorporated
 - d. Shurjoint Piping Products, Incorporated
 - e. Smith-Cooper International
 - f. Tyco Fire & Building Products
 - g. Victaulic Company
 - h. Viking Corporation
 - i. Ward Manufacturing
 - j. Allied Rubber and Gasket Company Incorporated, dba ARGCO
 - k. Dixon Valve & Coupling
 - l. Or approved equivalent.
5. Fittings, Welded:
- a. Anvil International
 - b. Shurjoint Piping Products Incorporated
 - c. Smith-Cooper International
 - d. State Pipe & Supply, Incorporated
 - e. Or approved equivalent.
6. Fittings, Flanged:
- a. United Brand Fittings
 - b. U.S. Pipe
 - c. Anvil S.P.F.
 - d. Iowa Fittings Company
 - e. Victaulic Groove/Flange Adapter
 - f. Tyco Fire Products; Grinnell Groove/Flange Adapter
 - g. Or approved equivalent.
- B. Aboveground Galvanized Steel Pipe and Fittings:
1. Pipe:
- a. Allied Tube & Conduit Corporation
 - b. Bull Moose Tube
 - c. Wheatland Tube Company
 - d. Youngstown Tube Company
 - e. Tex-Tube Company
 - f. State Pipe & Supply, Incorporated
 - g. Or approved equivalent.
2. Fittings, Mechanical and Grooved Couplings:
- a. Victaulic
 - b. Gruvlok
 - c. Shurjoint Piping Products Incorporated
 - d. Smith-Cooper International
 - e. Tyco Fire & Building Products
 - f. Viking Corporation
 - g. Allied Rubber and Gasket Company Incorporated, dba ARGCO
 - h. Anvil International
 - i. Dixon Valve & Coupling
 - j. Or approved equivalent.
3. Fittings, Threaded:

- a. Smith-Cooper International
 - b. Anvil International
 - c. Ward Manufacturing
 - d. Or approved equivalent.
4. Fittings, Rubber Gasketed:
- a. Anvil International
 - b. AnvilStar
 - c. Ebaa Iron, Incorporated
 - d. Shurjoint Piping Products Incorporated
 - e. Smith-Cooper International
 - f. Tyco Fire & Building Products
 - g. Victaulic Company
 - h. Viking Corporation
 - i. Ward Manufacturing
 - j. Allied Rubber and Gasket Company Incorporated, dba ARGCO
 - k. Dixon Valve & Coupling
 - l. Or approved equivalent.
5. Fittings, Welded:
- a. Anvil International
 - b. Shurjoint Piping Products Incorporated
 - c. Smith-Cooper International
 - d. State Pipe & Supply, Incorporated
 - e. Or approved equivalent.
- C. Wall and Floor Penetrations and Sleeves:
- 1. Allied Rubber and Gasket Company, Incorporated, dba ARGCO
 - 2. Fire Protection Products Incorporated
 - 3. Trumbel Link-Seal
 - 4. Eaton Crouse-Hinds Link-Seal
 - 5. Or approved equivalent.
- D. Hangers and Supports:
- 1. Cooper B-Line Tolco:
 - a. Ring Hangers:
 - 1) Model B3100, Figure 2000.
 - 2) Model B3100, Figure 2.
 - b. U-Bolts: Model B3188.
 - c. Straps:
 - 1) Figure 22.
 - 2) Figure 22L2.
 - 3) Figure 23.
 - 4) Figure 24.
 - 5) Figure 28.
 - 6) Figure 29.
 - 7) Model B3184.
 - d. Riser Clamps: Model B3373.
 - e. Pipe Clamps: Model B3140, Figure 4B.
 - 2. Automatic Fire Control Incorporated, dba Afcon.
 - 3. Anvil International
 - 4. ITW Buildex Sammys
 - 5. Erico International
 - 6. PHD Manufacturing Incorporated
 - 7. Or approved equivalent.
- E. Struts and Strut Clamps:
- 1. Struts:

- a. Cooper B-Line Tolco
 - b. Or approved equivalent.
2. Strut Clamps:
- a. Cooper B-Line Tolco; Model B2400.
 - b. Or approved equivalent.
- F. Sway Braces and Restraints:
1. Cooper B-Line Tolco:
- a. Fig. 75
 - b. Fig. 4A
 - c. Fig. 4L
 - d. Fig. 4LA
 - e. Fig. 800
 - f. Fig. 825
 - g. Fig. 825A
 - h. Fig. 828
 - i. Fig. 906
 - j. Fig. 910
 - k. Fig. 975
 - l. Fig. 980
 - m. Fig. 1000
 - n. Fig. 1001
 - o. Fig. 2002
2. Automatic Fire Control Incorporated, dba Afcon.
3. Anvil International
4. Erico International
5. PHD Manufacturing Incorporated
6. Or approved equivalent.
- G. Anchors and Attachments:
1. Concrete:
- a. Cast-In Place Anchors for Hangers:
 - 1) Cooper B-Line Tolco; Models 109, 109AF, B2500 with N2500 nut, or B3014 with B3014N nut.
 - 2) Automatic Fire Control Incorporated, dba Afcon.
 - 3) Erico International
 - 4) Or approved equivalent.
 - b. Cast-In Place Anchors for Braces:
 - 1) Cooper B-Line Tolco; Models B2500 with N2500 nut, or B3014 with B3014N nut.
 - 2) Anvil International; Figure 282 with nut.
 - 3) Automatic Fire Control Incorporated, dba Afcon.
 - 4) Erico International
 - 5) Or approved equivalent.
 - c. Attachments as specified or described by structural. If not specified or described by structural, then as follows:
 - 1) Hilti; Model Kwikbolt TZ
 - 2) Powers; Models Snake+, Power Stud+ SD2, or Powers Wedge-Bolt.
 - 3) Simpson Strong-Tie
 - 4) Or approved equivalent.
2. Wood:
- a. Cooper B-Line Tolco:
 - 1) Fig. 5D
 - 2) Fig. 51
 - 3) Fig. 56
 - 4) Fig. 58
 - 5) Fig. 78
 - 6) Fig. 120

- 7) Fig. 130
- b. Automatic Fire Control Incorporated, dba Afcon.
- c. Anvil International
- d. Erico International
- e. ITW Buildex Sammys
- f. Or approved equivalent.

3. Steel:

- a. Cooper B-Line Tolco:
 - 1) Model B3037
 - 2) Model B3033
 - 3) Model B3034
 - 4) Fig. 65
 - 5) Fig. 66
 - 6) Fig. 67
 - 7) Fig. 68
 - 8) Fig. 69
 - 9) Model B3042T
 - 10) Fig. 22L2
 - 11) Fig. 23
 - 12) Fig. 24
 - 13) Fig. 28
 - 14) Fig. 78
- b. Automatic Fire Control Incorporated, dba Afcon.
- c. Anvil International
- d. Erico International
- e. ITW Buildex Sammys
- f. Or approved equivalent.

H. Bells:

- 1. Interior/Exterior Alarm Bells:
 - a. Potter; Model PB, 8-inch.
 - b. System Sensor
 - c. Or approved equivalent.

I. Pipe Valve and Fire Protection Equipment Identification:

- 1. Fire Protection Products, Incorporated
- 2. Allied Rubber and Gasket Company, Incorporated, dba ARGCO
- 3. Or approved equivalent.

J. Signs:

- 1. Tyco Fire Products
- 2. Reliable Automatic Sprinkler
- 3. Viking Corporation
- 4. Allied Rubber and Gasket Company, Incorporated, dba ARGCO
- 5. Or approved equivalent.

K. Drains:

- 1. Reference Aboveground Black Steel Pipe and Fittings.
- 2. AGF
- 3. Victaulic
- 4. Or approved equivalent.

2.2 ABOVEGROUND BLACK STEEL PIPE AND FITTINGS

A. Wet Pipe Systems:

1. Pipe Size 2-inch Diameter and Smaller: ASTM A53, ASTM A135, or ASTM A795; minimum of Schedule 40 or minimum Corrosion Resistance Ratio (CRR) of 1.00 per UL Listing or FM Global Approval. Allied BLT/XL is not permitted.
 2. Pipe Size 2-1/2-inch Diameter and Larger: ASTM A53, ASTM A135, or ASTM A795; minimum of Schedule 10 or minimum CRR of 1.00 per UL Listing or FM Global approval. Wall thickness greater than Schedule 5. Schedule 5 not approved.
 3. Exposed pipe 8-feet or less above finished floor: A minimum of Schedule 40.
- B. Joints:
1. Threaded, flanged or bevel welded.
 2. Piping installed in plenums or shafts to have welded joints.
- C. Fittings:
1. Threaded:
 - a. Malleable Iron: Class 150 and Class 300, ANSI B16.3.
 - b. Cast Iron: Class 125 and 250, ANSI B16.3.
 2. Flanged:
 - a. Cast iron; Class 125 and 250, ASME B16.1.
 - b. Raised ground face, bolt holes spot faced.
 3. Welded:
 - a. Carbon Steel: Long radius, standard weight or extra strong.
 - b. Factory Wrought Steel Buttweld Fittings: ASME B16.9.
 - c. Buttwelding Ends for Pipe, Valves, Flanges and Fittings: ASME B16.25.
 - d. Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures: ASTM A234.
 - e. Steel Pipe Flanges and Flanged Fittings: ASME B16.5.
 - f. Forged Steel Fittings, Socket Welded and Threaded: ASME B16.11.
 4. Mechanical Fittings and Grooved Couplings:
 - a. Couplings: UL 213, AWWA C606, ASTM A536 ductile iron or ASTM A47 malleable iron, with enamel finish and grooves or shoulders designed to accept grooved couplings. Synthetic-rubber gasket with central-cavity, pressure-responsive design and ASTM A183 carbon-steel bolts and nuts.
 - b. FM Global approved.
- D. Anti-Microbial Coating: Factory-applied coating to inhibit corrosion from microbiological organisms.

2.3 ABOVEGROUND GALVANIZED STEEL PIPE AND FITTINGS

- A. Provide for dry pipe, preaction and deluge systems. Galvanized inside and out. Threaded or grooved.
- B. Pipe Size 2-inch Diameter and Smaller: Hot dipped galvanized ASTM A795; ASTM A123. Schedule 40 or Minimum Corrosion Resistance Ratio (CRR) of 1.00 per UL Listing or FM Global Approval. Allied BLT/XL is not permitted.
- C. Pipe Size 2-1/2-inch Diameter and Larger: ASTM A795; minimum of Schedule 10 or Minimum CRR of 1.00 per UL Listing or FM Global Approval. Wall thickness greater than Schedule 5. Schedule 5 not approved.
- D. Exposed pipe 8-feet or less above finished floor: A minimum of Schedule 40.
- E. Joints:
1. Threaded, flanged, grooved or bevel welded.
 2. Piping installed in plenums or shafts to have welded joints.
- F. Fittings:
1. General: Provide galvanized fittings where piping is exposed.
 2. Threaded:

- a. Malleable Iron: Class 150 and Class 300, ANSI B16.3.
- b. Cast Iron: Class 125 and 250, ANSI B16.3.
- 3. Flanged:
 - a. Cast iron; Class 125 and 250, ASME B16.1.
 - b. Raised ground face, bolt holes spot faced.
- 4. Welded:
 - a. Carbon Steel: Long radius, standard weight or extra strong.
 - b. Factory Wrought Steel Butt weld Fittings: ASME B16.9.
 - c. Butt welding Ends for Pipe, Valves, Flanges and Fittings: ASME B16.25.
 - d. Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures: ASTM A234.
 - e. Steel Pipe Flanges and Flanged Fittings: ASME B16.5.
 - f. Forged Steel Fittings, Socket Welded and Threaded: ASME B16.11.
- 5. Mechanical Fittings and Grooved Couplings:
 - a. Couplings: UL 213, AWWA C606, ASTM A536 ductile iron or ASTM A47 malleable iron, with enamel finish and grooves or shoulders designed to accept grooved couplings. Synthetic-rubber gasket with central-cavity, pressure-responsive design and ASTM A183 carbon-steel bolts and nuts.
 - b. FM Global approved.

2.4 WALL AND FLOOR PENETRATIONS AND SLEEVES

- A. Below Grade and High Water Table Areas: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal.

2.5 HANGERS AND SUPPORTS

- A. General: Select size of hangers and supports to exactly fit pipe size for bare piping.
- B. Hangers: Ferrous.
- C. Hanger Rods:
 - 1. Concealed Spaces: Continuously threaded or threaded ends.
 - 2. Exposed Spaces: Threaded ends.
- D. Finishes: Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- E. Materials:
 - 1. Use carbon steel pipe hangers and supports, metal trapeze pipe hangers and attachments for general service applications.
 - 2. Use corrosion-resistant attachments for highly corrosive or hostile environment applications.
- F. Anti-Scratch Padding: Use padded hangers for piping subject to scratching.

2.6 STRUTS AND STRUT CLAMPS

- A. Electro-galvanized steel.
- B. Designed for supporting pipe runs from strut supports.
- C. UL listed for pipe up to 8-inches in diameter.

2.7 SWAY BRACES AND RESTRAINTS

- A. Sway Bracing: From a single manufacturer and compatible with sway brace calculation program.

2.8 ANCHORS AND ATTACHMENTS

- A. General: Anchor supports to masonry, concrete and block walls per anchoring system manufacturer's recommendations, or as modified by project Structural Engineer.
- B. Cast in Place Anchors for Hangers:
 - 1. Ferrous.
 - 2. Verify listing is for hangers, braces, or both.
- C. Attachments in Concrete:
 - 1. Suitable for hanging and bracing fire protection systems in concrete which is subject to cracking in a seismic event.
 - 2. Seismic Design Areas C, D, E and F:
 - a. Compatible with International Code Council Evaluation Service Acceptance Criteria AC-193 and AC308 for expansion, screw and adhesive anchors. Meet requirements of ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary.
 - b. All models of Hilti HDI and ITW Red Head Multi-Set II anchors are not approved for attaching fire protection systems in Seismic Design Areas C, D, E and F. No Exceptions.
- D. ITW Buildex Sammys with FM Approval only are not allowed in certain seismic zones. Verify with FM that FM Approval is effective in project's seismic zone.

2.9 BELLS

- A. Exterior Alarm Bells: Minimum weatherproof backbox, typical 90 dBA at 10-feet.

2.10 PIPE VALVE AND FIRE PROTECTION EQUIPMENT IDENTIFICATION

- A. Engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker.
- B. Corrosion-resistant chain or permanent adhesive.

2.11 SIGNS

- A. Engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker.
- B. Corrosion-resistant chain or permanent adhesive.

2.12 DRAINS

- A. Reference Aboveground Black Steel Pipe and Fittings.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install in conformance with UL Listing, FM Approval or ICC-ES requirements and restrictions.

3.2 ABOVEGROUND BLACK STEEL PIPE AND FITTINGS

- A. Piping Routing:
 - 1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.
 - 2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
 - 3. Install piping in concealed spaces above finished ceilings. Prior to design and installation, obtain pre-approval by Architect for exposed piping.

4. In open-to-structure areas which are open to public view, route exposed piping to minimize visual impact. Obtain Architect's and Engineer's approval of exposed piping installation.
 5. Coordinate installation with other trades. Route piping as required to avoid building structure, equipment, plumbing piping, HVAC piping, ductwork, lighting fixtures, electrical conduits and bus ducts and similar work. Final location of lighting will have priority over final sprinkler locations. Provide drains to trapped Sections of system which result from such routing. Other trades take precedence for installation space.
 6. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 2-inches wherever furring is indicated for concealment of piping. Allow for insulation thickness. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
 7. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.
 8. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3-foot lateral clearance from sides of electric switchgear panels. Do not route piping above electric power or lighting panel, switchgear, or similar electric device. Coordinate with electrical and coordinate exact pipe routing to provide proper clearance with such Item.
 9. Route water filled and dry system piping around, not into or through, rooms protected by pre-action systems, clean-agent systems, gaseous suppression systems and other alternative fire suppression systems.
 10. Install piping as close as possible to ceiling to avoid conflicts with other trades.
 11. Install pipe runs to minimize obstruction to other work.
- B. Couplings:
1. Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
 2. Deburr cut edges.
- C. Pipe Penetrations: Wire pipe cutout coupon at point of pipe penetration.
- D. Pipe and Pipe Fittings:
1. Expansion and Flexibility: Install work with due regard for expansion and contraction to prevent damage to the piping, equipment, building and its contents. Provide piping offsets, loops, approved type expansion joints, sway bracing, wire restraints, vertical restraints, flexible couplings or other means to control pipe movement and to minimize pipe forces.
 2. Coordinate support of pipe 4-inches and larger with Structural Engineer.
 3. Provide clearances around piping per NFPA 13.
 4. Pitch pipe for dry system piping located or passing through warm as well as cold areas.
 5. Install welded pipe with welds facing vertically up, or where this is not possible, as close as possible to vertical between 46 degrees and 234 degrees. Intent is to minimize corrosion caused by moisture in the bottom of pipes.

3.3 ABOVEGROUND GALVANIZED STEEL PIPE AND FITTINGS

- A. Piping Routing:
1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.
 2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
 3. Install piping in concealed spaces above finished ceilings.

4. In open-to-structure areas which are open to public view, route exposed piping to minimize visual impact. Obtain Architect's and Engineer's approval of exposed piping installation.
 5. Coordinate installation with other trades. Route piping as required to avoid building structure, equipment, plumbing piping, HVAC piping, ductwork, lighting fixtures, electrical conduits and bus ducts and similar work. Final location of lighting will have priority over final sprinkler locations. Provide drains to trapped Sections of system which result from such routing. Other trades take precedence for installation space.
 6. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 2-inches wherever furring is indicated for concealment of piping. Allow for insulation thickness. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
 7. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.
 8. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3-foot lateral clearance from sides of electric switchgear panels. Do not route piping above electric power or lighting panel, switchgear, or similar electric device. Coordinate with electrical and coordinate exact pipe routing to provide proper clearance with such Item.
 9. Route water filled and dry system piping around, not into or through, rooms protected by pre-action systems, clean-agent systems, gaseous suppression systems and other alternative fire suppression systems.
 10. Install piping as close as possible to ceiling to avoid conflicts with other trades.
 11. Install pipe runs to minimize obstruction to other work.
- B. Couplings:
1. Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
 2. Deburr cut edges.
- C. Pipe Penetrations: Wire pipe cutout coupon at point of pipe penetration.
- D. Pipe and Pipe Fittings:
1. Expansion and Flexibility: Install work with due regard for expansion and contraction to prevent damage to the piping, equipment, building and its contents. Provide piping offsets, loops, approved type expansion joints, sway bracing, wire restraints, vertical restraints, flexible couplings or other means to control pipe movement and to minimize pipe forces.
 2. Coordinate support of pipe 4-inches and larger with Structural Engineer.
 3. Provide clearances around piping per NFPA 13.
 4. Pitch pipe for dry system piping located or passing through warm as well as cold areas.

3.4 WALL AND FLOOR PENETRATIONS AND SLEEVES

- A. Escutcheons: Install on exposed pipes passing through walls or floors.
1. Pipe Sleeves: Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
 2. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor. Caulk pipes passing through floor with nonshrinking fire and water resistant grout or approved equivalent caulking compound. Provide "Link-Seal" sleeve sealing system for slab on grade. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
 3. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with non-shrinking caulking compound. Caulk/seal piping passing through fire-rated building assemblies

with UL Listed or FM Approved fire-rated firestopping compound. Provide fire-rated assemblies per local AHJ requirements.

4. Beam Sleeves:
 - a. Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Penetrations must be indicated on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.
 - b. Firestopping penetrations in fire-rated wall/floor assemblies.
 - c. Reference Division 07, Thermal and Moisture Protection.
 - d. Coordinate with Drawings location of fire rated walls, ceilings and floors. When these assemblies are penetrated, seal around piping and equipment with approved firestopping material.
 - e. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814 and NFPA.
 - f. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

3.5 HANGERS AND SUPPORTS

- A. Installation of pipe hangers, inserts and supports to conform to NFPA 13. Provide adjustable hangers, inserts, brackets, clamps, supplementary steel and other accessory materials required for proper support of pipe lines and equipment. Provide supplementary materials for proper support and attachment of hangers.

3.6 STRUTS AND STRUT CLAMPS

- A. Install per manufacturer's listed orientation.

3.7 SWAY BRACES AND RESTRAINTS

- A. Locate per orientation and spacing as required by sway brace calculations.
- B. Attach sway bracing directly to pipe or equipment being braced.
- C. Do not attach sway bracing to bottom of truss members.

3.8 ANCHORS AND ATTACHMENTS

- A. In post-tension construction, determine location of post-tension cables and install anchors to avoid contact or interference with post-tension cables. Coordinate with Structural.
- B. Do not use powder-driven attachments.
- C. Building Attachments and Inserts: Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves and flanges, for sizes NPS 2-1/2 and larger. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- D. Hanger and Support Attachments:
 1. Concrete:
 - a. Before Pouring: Support piping and equipment from malleable iron concrete form inserts placed before concrete is poured.
 - b. After Pouring:
 - 1) Where supports in slabs are required after concrete has been poured, provide drilled-in threaded inserts (mechanical-expansion anchors), installed in accordance with manufacturer's recommendations.

- 2) Install mechanical-expansion anchors after concrete is completely cured and in accordance with manufacturer's installation instructions.
2. Metal Floor Deck: Support hangers per UL Listing or FM Approval for selected concrete insert before pouring of concrete topping, or from beam clamps fastened to structural steel.
3. Steel Joists: Support hangers from beam clamps fastened to bar joists or to auxiliary steel between bar joists as required.
4. C-Clamp Hangers: Do not attach to one side of double-angle bottom members.

3.9 BELLS

- A. Locate exterior alarm bells at 8-feet above finished grade. Coordinate with Architect.
- B. Coordinate with Divisions 26, Electrical and Division 28, Electronic Security.

3.10 PIPE VALVE AND FIRE PROTECTION EQUIPMENT IDENTIFICATION

- A. Install engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker, secured with corrosion-resistant chain or permanent adhesive on or near each item of fire suppression equipment and each operational device, as specified in this specification if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices: Valves, drains, pumps, standpipes, tanks and similar equipment. Provide valve tag on every valve and control device in each piping system. Exclude check valves and valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.
- B. Each new piece of equipment to bear a permanently attached identification plate, listing manufacturer's name, capacities, sizes and characteristics.
- C. Piping to bear the manufacturer's name, schedule of thickness, size and ASTM identification number
- D. Provide valve tag on every valve and control device in each piping system. Exclude check valves and valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.
- E. Drain, Auxiliary Drain and Drum Drips: Provide valve tag on every valve in each fire suppression system. List each tagged valve and its location in valve schedule, identify on fire suppression drawings.
- F. Install framed, glass or rigid transparent plastic covered, mounted valve schedule and valve location drawing in main riser or fire pump room.
- G. Provide identification sign on ceiling tile below valve location.
- H. Provide permanent identification sign at pressure regulating valves stating required setting of pressure regulator.
- I. Adjusting: Relocate fire suppression identification device which has become visually blocked.
- J. Cleaning: Clean face of identification devices and glass frames of valve charts.

3.11 SIGNS

- A. General Information Signs: Provide a general information sign used to determine system design basis and information relevant to the inspection, testing and maintenance requirements required by NFPA 25, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems. Such general information is to be provided with a permanently marked weatherproof metal or rigid plastic sign, secured with corrosion-resistant wire, chain, or other acceptable means. Such signs are to be placed at each system control rise loop and auxiliary system control valve. The sign is to include the following information:
 1. Name and Location of the Facility Protected

2. Presence of High-Piled and/or Rack Storage
 3. Maximum Height of Storage Planned
 4. Flow Test Data
 5. Location of Auxiliary Drains and Low Point Drains
 6. Original Results of Main Drain Flow Test
 7. Name of Installing Contractor or Designer
 8. Indication of presence and location of other auxiliary systems.
- B. Dry Signs: At system riser supplying dry systems, provide the following information: volume in gallons contained in each system.

3.12 DRAINS

- A. Locate drain connections within 7-feet of floor. Provide piping capable of being fully drained.
- B. Provide a drain vent at top of vertical drains. Coordinate with Division 22, Plumbing.
- C. Coordinate location of auxiliary drains with Architect. Architect to approve location before drain is installed.
- D. Protect drains from tampering and accidental operation.
- E. Protect drain discharge at the exterior with a turned-down 45 degree elbow.

END OF SECTION

**SECTION 211300
FIRE SUPPRESSION SPRINKLER SYSTEMS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Sprinklers
 - 2. Flexible Sprinkler Hose Assembly
 - 3. Oversized Sprinkler Escutcheons
- B. This is a contractor designed system. Contact AHJ prior to bid to verify fire system requirements. Provide design compliant with codes as interpreted by AHJ.
- C. Scope:
 - 1. Revision and extension of existing system in Main Building to new and remodeled areas.
 - 2. Sprinkler protection for areas subject to 40 degrees F and lower: Dry-pipe sprinkler system, dry sprinklers in areas subject to 40 degrees F or less.
 - 3. Perform an interior inspection of existing piping in Main Building to determine feasibility of reuse.
 - 4. Replace portions of piping in Main Building showing rust.
 - 5. Provide a new fire bell or horn strobe, as required by the fire marshal.
- D. Coordinate location and type of tamper, flow and pressure switches and fire alarm system.
- E. Provide electrical connections and wiring as required for a complete and operable system. Includes but is not limited to bells, air compressors, sump pumps, fire pumps, jockey pumps and pump controllers.

1.2 RELATED SECTIONS

- A. Contents of Division 21, Fire Suppression and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Division 22, Plumbing
 - 2. Division 23, Heating, Ventilating and Air-Conditioning
 - 3. Division 26, Electrical
 - 4. Division 28, Electronic Security
 - 5. Section 21 00 00, Fire Suppression Basic Requirements
 - 6. Section 21 05 00, Common Work Results for Fire Suppression

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Details of sway bracing.
 - 2. Details of interval and end of branch line restraints.

3. Details of flexible sprinkler hose assembly, including number and radius of bends, corresponding to equivalent feet used in hydraulic calculations.
4. Details of oversized ceiling penetrations and oversized sprinkler escutcheons.
5. Trapeze hanger details and calculations, including size, length and material. Additionally, provide size, weight and number of pipes to be carried on the trapeze.
6. Per County of San Mateo Cal Fire, Fire Marshal's Requirements, provide the following:
 - a. As-Builts for the existing fire sprinkler system with no calculations.
 - b. Provide new calculations if there is any change of more than 10 sprinklers or if there are any changes to the most remote area.
 - c. Provide specifications / cut sheets for all new proposed equipment for the fire sprinkler system.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.7 SYSTEM DESCRIPTION

- A. Provide coverage for entire building. Field verify field conditions prior to submittal of bid. Adjust bid to provide protection features in accordance with applicable codes and interpretations by AHJ. Provide design and installation based on more stringent requirements if this specification and AHJ requirements differ from Code.
- B. Design Parameters: Assign sprinkler systems design requirements as defined in Code to areas and obtain approvals for these requirements from appropriate reviewing authority. These requirements include hazard classifications, sprinkler temperature ratings, density, sprinkler area and water supply requirements and availability. Provide fire pump with Code-required appurtenances and electrical requirements for complete and working water supply system if results of water supply test and hydraulic calculations indicate need for a booster pump. Provide design and installation based on more stringent requirement if AHJ requirements differ from Code.

1.8 EXTRA STOCK

- A. Provide extra sprinklers per code.
- B. Provide suitable wrenches for each sprinkler type and metal storage cabinet in riser room.
- C. Inside the cabinet, provide a list of sprinklers installed in the property, including sprinkler identification number, manufacturer, model, orifice, deflector type, thermal sensitivity and pressure rating, quantity of each type to be contained in the cabinet and issue or revision date of the list.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Sprinklers:
 1. Finished Areas:
 - a. Viking
 - b. Tyco
 - c. Reliable
 - d. Victaulic

- e. Globe
 - f. Senju
 - g. Or approved equivalent.
- 2. Nonfinished Areas:
 - a. Viking
 - b. Tyco
 - c. Reliable
 - d. Victaulic
 - e. Globe
 - f. Or approved equivalent.
 - 3. Dry Sprinklers:
 - a. Viking
 - b. Tyco
 - c. Reliable
 - d. Victaulic
 - e. Or approved equivalent.
 - 4. Institutional Sprinklers:
 - a. Tyco Fire Protection Products, Raven
 - b. No substitutions.
- B. Flexible Sprinkler Hose Assembly:
- 1. Flexhead Industries
 - 2. SprinkFLEX
 - 3. Allied Rubber and Gasket Company, Incorporated, dba ARGCO
 - 4. Reliable Automatic Sprinkler Company
 - 5. Tyco Fire and Building Products
 - 6. Victaulic
 - 7. Or approved equivalent.
- C. Oversized Sprinkler Escutcheons:
- 1. Viking Corporation; Expansion Plate
 - 2. Tyco Fire Protection Products; Wide Adapter Plates
 - 3. Reliable Automatic Sprinkler; Extender Rings
 - 4. Victaulic; FireLock Expansion Plates
 - 5. Globe Fire Sprinkler Corporation; Seismic Escutcheons
 - 6. Or approved equivalent.

2.2 SPRINKLERS

- A. Finished Areas:
- 1. Type: Glass-Bulb
 - 2. Style: Recessed
 - 3. Response: Quick-Response
 - 4. Finish:
 - a. Chrome
 - b. White Polyester
 - 5. Escutcheon: White Polyester
- B. Nonfinished Areas:
- 1. Type: Glass-Bulb
 - 2. Response: Quick-Response
 - 3. Finish: Brass

- C. Dry Sprinklers:
 - 1. Type: Glass-Bulb
 - 2. Style: Recessed
 - 3. Response: Quick-Response
 - 4. Finish:
 - a. Chrome
 - b. White Polyester
 - 5. Escutcheon:
 - a. Chrome
 - b. White Polyester
 - 6. Dry Sprinkler Boot: Manufactured for use with the dry sprinkler it protects.
- D. Institutional Sprinklers at Dorm Rooms and Bath Rooms:
 - 1. Response: Quick-Response
 - 2. Finish:
 - a. Chrome
 - b. White
 - 3. Escutcheon:
 - a. Chrome
 - b. White

2.3 FLEXIBLE SPRINKLER HOSE ASSEMBLY

- A. Fully welded non-mechanical fittings, stainless steel, braided, leak-tested with minimum 1-inch true-bore internal corrugated hose diameter. 175 psi.
- B. Ceiling Bracket: Galvanized steel, direct attachment type, with integrated snap-on clip ends and removable flexible hose attachment with set screw. FM1637, UL 2443.

2.4 OVERSIZED SPRINKLER ESCUTCHEONS

- A. Metal.
- B. Provide oversized ceiling penetrations and oversized sprinkler escutcheons for pendent sprinklers to comply with Building Code and ASCE-7 seismic requirements.
- C. Same manufacturer as sprinklers.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install per manufacturer's requirements and recommendations.

3.2 SPRINKLERS

- A. Center sprinklers in center or quarter points of suspended ceiling tile.
- B. Align sprinklers with architectural column lines, lighting, diffusers and other ceiling features. In unfinished ceilings, route piping to minimize visual impact. Sprinklers and piping not so aligned are to be removed and replaced at no additional cost to Owner.
- C. Install dry sprinklers in a manner which does not trap water.
- D. Provide institutional sprinklers at Dorm Rooms and Bath Rooms.

3.3 FLEXIBLE SPRINKLER HOSE ASSEMBLY

- A. Install with no more bends than are included in equivalent footage used in hydraulic calculations.
- B. Maintain manufacturer's recommended bending radius as included in equivalent footage used in hydraulic calculations.

3.4 OVERSIZED SPRINKLER ESCUTCHEONS

- A. Coordinate oversized sprinkler escutcheons with ceiling construction and sprinkler style.
- B. Provide for dry sprinkler penetrations in suspended ceilings.

END OF SECTION

**SECTION 220000
PLUMBING BASIC REQUIREMENTS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in 22 00 00, Plumbing Basic Requirements applies to Division 22, Plumbing work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of plumbing systems for proposed project.
- B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. Definitions:
 - 1. Provide: To furnish and install, complete and ready for intended use.
 - 2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
 - 3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
 - 4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
 - 5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.2 RELATED SECTIONS:

- A. Contents of Section applies to Division 22, Plumbing Contract Documents.
- B. Related Work:
 - 1. Additional conditions apply to this Division including, but not limited to:
 - a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - b. Drawings
 - c. Addenda
 - d. Owner/Architect Agreement
 - e. Owner/Contractor Agreement
 - f. Codes, Standards, Public Ordinances and Permits

1.3 REFERENCES AND STANDARDS

- A. References and Standards per Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, individual Division 22, Plumbing Sections and those listed in this Section.
- B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 - 1. State of California:
 - a. CBC California Building Code
 - b. CEC California Electrical Code
 - c. CEC T24 California Energy Code Title 24

- d. CFC California Fire Code
- e. CMC California Mechanical Code
- f. CPC California Plumbing Code
- g. CSFM California State Fire Marshal
- h. DSA Division of State Architect Regulations and Requirements

C. General: Reference standards and guidelines include but are not limited to the latest adopted editions from:

1. ABA Architectural Barriers Act
2. ADA Americans with Disabilities Act
3. AHRI Air-Conditioning Heating & Refrigeration Institute
4. ANSI American National Standards Institute
5. ASCE American Society of Civil Engineers
6. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
7. ASHRAE Guideline 0, the Commissioning Process
8. ASME American Society of Mechanical Engineers
9. ASPE American Society of Plumbing Engineers
10. ASSE American Society of Sanitary Engineering
11. ASTM ASTM International
12. AWWA American Water Works Association
13. CFR Code of Federal Regulations
14. CGA Canadian Gas Association
15. CISPI Cast Iron Soil Pipe Institute
16. CSA CSA International
17. ETL Electrical Testing Laboratories
18. EPA Environmental Protection Agency
19. FDA Food & Drug Administration
20. FM FM Global
21. IAPMO International Association of Plumbing and Mechanical Officials
22. GAMA Gas Appliance Manufacturers Association
23. HI Hydraulic Institute Standards
24. ISO International Organization for Standardization
25. MSS Manufacturers Standardization Society
26. NEC National Electric Code
27. NEMA National Electrical Manufacturers Association
28. NFGC National Fuel Gas Code
29. NFPA National Fire Protection Association
30. NRCA National Roofing Contractors Association
31. NSF National Sanitation Foundation
32. OSHA Occupational Safety and Health Administration
33. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
34. TEMA Tubular Exchanger Manufacturers Association
35. TIMA Thermal Insulation Manufacturers Association
36. UL Underwriters Laboratories Inc.
37. USDA United States Department of Agriculture

D. See Division 22, Plumbing individual Sections for additional references.

E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for

equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

- F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.
- G. Piping Insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.4 SUBMITTALS

- A. See Division 01, General Requirements for Submittal Procedures as well as specific individual Division 22, Plumbing Sections.
- B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.
- C. In addition:
 - 1. "No Exceptions Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
 - 2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
 - 3. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 22, Plumbing Sections.
 - 4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
 - a. Label submittal to match numbering/references as shown in Contract Documents and schedules. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
 - b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference Division 22, Plumbing Sections for specific items required in product data submittal outside of these requirements.
 - c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
 - d. For vibration isolation of equipment, list make and model selected with operating load and deflection. Indicate frame type where required. Submit manufacturer's product data.
 - e. See Division 22, Plumbing Sections for additional submittal requirements outside of these requirements.
 - 5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
 - 6. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide

- engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
7. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 22, Plumbing Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
 8. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
 9. Substitutions and Variation from Basis of Design:
 - a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
 - b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.
 10. Shop Drawings: Provide coordinated Shop Drawings which include physical characteristics of all systems, equipment and piping layout plans, and control wiring diagrams. Reference individual Division 22, Plumbing Sections for additional requirements for Shop Drawings outside of these requirements.
 - a. Provide Shop Drawings indicating sanitary and storm cleanout locations and type to Architect for approval prior to installation.
 - b. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
 11. Samples: Provide samples when requested by individual Sections.
 12. Resubmission Requirements:
 - a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
 - 1) Resubmit for review until review indicates no exceptions taken or "make corrections as noted".
 - 2) When submitting drawings for Engineers re-review, clearly indicate changes on drawings and "cloud" any revisions. Submit a list describing each change.
 13. Operation and Maintenance Manuals, Owners Instructions:
 - a. Submit, at one time, one bound copy and electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
 - 1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
 - 2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.

- 3) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
 - 4) Include copy of startup and test reports specific to each piece of equipment.
 - 5) Include copy of final water systems balancing log along with pump operating data.
 - 6) Include commissioning reports.
 - 7) Include copy of pressure, flow, leakage and purity test data and water systems test data, as applicable. Include copy of third-party and state and local jurisdiction inspection reports.
 - 8) Include copy of valve charts/schedules.
 - 9) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
 - 10) Include product certificates of warranties and guarantees.
 - 11) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
- b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 22 00 00, Plumbing Basic Requirements article titled "Demonstration".
 - c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.
14. Record Drawings:
- a. Maintain at site at least one set of drawings for recording "As-constructed" conditions. Indicate on Drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
 - b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
 - c. At completion of project, input changes to original project on CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
 - d. Provide Invert elevations and dimensioned locations for water services, building waste, and storm drainage piping below grade extending to 5-feet outside building line.
 - e. See Division 22, Plumbing individual Sections for additional items to include in record drawings.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed to conform with all local, State, Federal and other applicable laws and regulations.
- B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturers equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.
- C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- E. UL and CSA Compliance: Provide products which are UL listed.

- F. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.
- G. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.

1.6 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Contracting and Procurement Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty in Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.7 COORDINATION DOCUMENTS

- A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
- B. Advise Architect in the event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
- C. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.
- D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide like items from one manufacturer, including but not limited to fixtures, pumps, drains and equipment.

2.2 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities.
- B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
- C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- D. Hazardous Materials:
 - 1. Comply with local, State of California, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.

3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 22, Plumbing Sections. In the absence of specific requirements, comply with the following:
 1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
 - a. Ceiling access panels to be minimum 24-inch by 24-inch required and approved size.
 - b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
 - c. Provide two keys for each set of keyed cylinder type locks.
 - d. Manufacturers and Models:
 - 1) Drywall: Karp KDW.
 - 2) Plaster: Karp DSC-214PL.
 - 3) Masonry: Karp DSC-214M.
 - 4) 2 hour rated: Karp KPF-350FR.
 - 5) Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- B. Install equipment requiring access (i.e., drain pans, drains, control operators, valves, motors, cleanouts and water heaters) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.
- C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.
- D. Earthwork:
 1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
 - a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with the provisions of related earthwork Sections/divisions. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
 - b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
 - c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.
- E. Firestopping:

1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
 - a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Pipe Installation:

1. Coordinate work to account for expansion and contraction of piping materials and building as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, expansion joints, sleeves, anchors or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products and rating for coordinating installation of piping systems.
2. Include provisions for servicing and removal of equipment without dismantling piping.

G. Plenums:

1. Provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22 Plumbing Sections.

- B. Equipment Importance Factor: 1.0.

C. General:

1. Confirm Building Risk Category and Seismic Design Category with Architect and Structural Engineer.
2. Earthquake resistant designs for Plumbing (Division 22, Plumbing) equipment and distribution, i.e. motors, plumbing systems, piping, equipment, water heaters, boilers, etc. conform to regulations of jurisdiction having authority.
3. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
4. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.
5. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.

D. Piping:

1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA or local requirements.

E. Equipment:

1. Provide means to prohibit excessive motion of plumbing equipment during earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
 - 1. Underground piping installation prior to backfilling.
 - 2. Prior to covering walls.
 - 3. Prior to ceiling cover/installation.
 - 4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
- C. Bear responsibility and cost to make piping accessible, to expose concealed lines, or to demonstrate acceptability of the system. If Contractor fails to notify Architect at times prescribed above, costs incurred by removal of such work are the responsibility of the Contractor.
- D. Final Punch:
 - 1. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.4 CONTINUITY OF SERVICE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
 - 1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
 - 2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping, and wiring to point of connection.
 - 3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
 - a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 - 4. Organize work to minimize duration of power interruption.

3.5 CUTTING AND PATCHING

- A. Confirm Cutting and Patching requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
 - 1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
 - 2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
 - 3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
 - 4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing piping and devices are removed as part of this project.

Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.

5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

- A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

3.7 DELIVERY, STORAGE AND HANDLING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
 1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.
 2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
 3. Protect bright finished shafts, bearing housings and similar items until in service.

3.8 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.9 CLEANING

- A. Confirm cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

- A. Confirm installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

- C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
 - 1. Do not place equipment in sustained operation prior to initial balancing of plumbing systems.
 - 2. Provide pump impellers to obtain Basis of Design design capacities.
- D. Provide miscellaneous supports/metals required for installation of equipment and piping.

3.11 PAINTING

- A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
 - 1. Ferrous Metal: After completion of plumbing work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt for exterior or black enamel for interior, suitable for hot surfaces.
 - 2. In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
 - 3. See individual equipment Specifications for other painting.
 - 4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
 - 5. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.
 - 6. Covers: Covers such as manholes, cleanouts and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

- A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements in Division 01, General Requirements, comply with individual Division 22, Plumbing Sections and the following:
 - 1. Coordinate locations/sizes of access panels with Architect prior to work. Label access panels with engraved nameplates indicating function of panel.

3.13 DEMOLITION

- A. Confirm Demolition requirements in Division 01, General Requirements and Division 0. In absence of specific requirements, comply with individual Sections in Division 22, Plumbing and the following:
 - 1. Scope:
 - a. It is the intent of these documents to provide necessary information and adjustments to plumbing system required to meet code, and accommodate installation of new work.
 - b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
 - c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
 - 2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.
 - 3. Unless specifically indicated on Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.
 - 4. Unless specifically indicated on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).

3.14 ACCEPTANCE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Sections in Division 22, Plumbing and the following:
 - 1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
 - a. Testing and Balancing Reports
 - b. Cleaning
 - c. Operation and Maintenance Manuals
 - d. Training of Operating Personnel
 - e. Record Drawings
 - f. Warranty and Guaranty Certificates
 - g. Start-up/Test Document and Commissioning Reports

3.15 FIELD QUALITY CONTROL

- A. Confirm Field Quality Control requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- B. Tests:
 - 1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in operation and maintenance manuals.
 - 2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 ELECTRICAL INTERLOCKS

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

END OF SECTION

**SECTION 220516
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
1. Flexible Pipe Connectors, Copper Piping
 2. Flexible Expansion Loop (for Thermal and Seismic Applications), Steel Piping
 3. Flexible Expansion Loop (for Thermal and Seismic Applications), Copper Piping

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements. Include items listed below.
- B. In addition, provide:
1. Shop drawings for review and approval by Engineer. Illustrate Design Data and Expansion Joints items below on the Shop Drawing Submittal.
 2. Design Data: Indicate selection calculations.
 3. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
 4. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
 5. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - a. Extra Packing for Packed Expansion Joints: One set for each joint.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Flexible Pipe Connectors, Copper Piping:
1. Mercer Rubber Company
 2. Metraflex Company
 3. Mason
 4. Hyspan

5. Or approved equivalent.
- B. Flexible Expansion Loop (for Thermal and Seismic Applications), Steel Piping:
1. Mercer Rubber Company
 2. Metraflex Company
 3. Mason
 4. Hyspan
 5. Or approved equivalent.
- C. Flexible Expansion Loop (for Thermal and Seismic Applications), Copper Piping:
1. Mercer Rubber Company
 2. Metraflex Company
 3. Mason
 4. Hyspan
 5. Or approved equivalent.

2.2 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Inner Hose: Bronze, close pitch, annular corrugated hose.
- B. Exterior Sleeve: Braided bronze (piping over 2-inches to be 3 pound braided stainless steel).
- C. Pressure Rating: 125 PSI at 70 degrees F with a 4 to 1 safety factor.
- D. Joint: Sweat ends.
- E. Size: Use pipe sized units.
- F. Maximum offset: 3/8-inch on each side of installed center line.
- G. Basis of Design: Metraflex Model BBS.

2.3 FLEXIBLE EXPANSION LOOP (FOR THERMAL AND SEISMIC APPLICATIONS) - STEEL PIPING

- A. Construction: Two flexible Sections of hose and braid, two 90 degree elbows and a 180 degree return designed so piping does not change direction but maintains course along a single axis. Use Vee Loop where space is limited. System to import no thrust loads to system support anchors or building structure.
- B. Inner Hose: 304 stainless steel, close pitch, annular corrugated hose.
- C. Exterior Sleeve: Single braided, 304 stainless steel.
- D. Pressure Rating: 125 PSI at 70 degrees F with a 4 to 1 safety factor.
- E. Joint: ANSI Class 150 carbon steel flanges.
- F. Size: Use pipe sized units.
- G. Support: Center support at bottom of 180 degree return.
- H. Drain/Air Release: At bottom of 180 degree return.
- I. For Natural Gas: Approved by the CSA and complying with UL536.
- J. Basis of Design: Metraflex Metraloop. Vee configuration Mason-Mercer VFL.

2.4 FLEXIBLE EXPANSION LOOP (FOR THERMAL AND SEISMIC APPLICATIONS) - COPPER PIPING

- A. Construction: Two flexible Sections of hose and braid, two 90 degree elbows and a 180 degree return designed so piping does not change direction, but maintains course along a single axis. Use Vee Loop where space is limited. System to import no thrust loads to system support anchors or building structure.
- B. Inner Hose: Bronze, close pitch, annular corrugated hose.
- C. Exterior Sleeve: Braided bronze.
- D. Pressure Rating: 125 PSI at 70 degrees F with a 4 to 1 safety factor.
- E. Joint: Sweat ends.
- F. Size: Use pipe sized units.
- G. Support: Center support at bottom of 180 degree return.
- H. Basis of Design: Metraflex Metraloop. Vee configuration Mason-Mercer VCPSB.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Expansion/Contraction Fitting Installation:
 - 1. Install expansion/contraction fittings according to manufacturer's written instructions.
 - 2. Install expansion/contraction fittings in sizes matching pipe size in which they are installed.
 - 3. Align expansion/contraction fittings to avoid end-loading and torsional stress.
 - 4. Install in accordance with EJMA (Expansion Joint Manufacturer's Association) Standards.
 - 5. Wood structures: install expansion/contraction fittings and guides at every floor.
 - 6. Concrete structures: install expansion/contraction fittings and guides at interval spacing recommended by the manufacturers.
- B. Pipe Bend and Loop Installation:
 - 1. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
 - 2. Attach pipe bends and loops to anchors.
 - a. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code Section IX, "Welding and Brazing Qualifications."
 - b. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.
- C. Swing Connections:
 - 1. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
 - 2. Connect mains, risers and branch connections to equipment with at least four pipe fittings, including tee in riser.
- D. Guide Installation:
 - 1. Install guides on piping adjoining expansion fittings and loops.
 - 2. Attach guides to pipe and secure to building structure.
- E. Anchor Installation:
 - 1. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

2. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
 3. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
 4. Install pipe anchors according to expansion fitting manufacturer's written instructions if expansion fittings are indicated.
 5. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.
- F. Painting:
1. Touch Up: Clean field welds and 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-PA1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
 2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.2 FLEXIBLE PIPE CONNECTORS, COPPER PIPING

- A. See General Installation Requirements above.
- B. Install per manufacturers written recommendations and requirements.

3.3 FLEXIBLE EXPANSION LOOP (FOR THERMAL AND SEISMIC APPLICATIONS), STEEL PIPING

- A. See General Installation Requirements above.
- B. Install per manufacturers written recommendations and requirements.

3.4 FLEXIBLE EXPANSION LOOP (FOR THERMAL AND SEISMIC APPLICATIONS), COPPER PIPING

- A. See General Installation Requirements above.
- B. Install per manufacturers written recommendations and requirements.

END OF SECTION

SECTION 220519 PLUMBING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Pressure Gauges
 - 2. Thermometers
 - 3. Water Hammer Arrestors (Shock Absorbers) - Bellows and Piston Type
 - 4. Trap Primers

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pressure Gauges:
 - 1. Dwyer Instruments, Inc.
 - 2. Moeller Instrument Co., Inc.
 - 3. Omega Engineering, Inc.
 - 4. Trerice
 - 5. Or approved equivalent.
- B. Thermometers:
 - 1. Ashcroft
 - 2. Trerice
 - 3. Weiss
 - 4. Marshaltown
 - 5. Weksler
 - 6. Or approved equivalent.

C. Water Hammer Arrestors (Shock Absorbers), Bellows Type:

1. Bellows Type:
 - a. Amtrol
 - b. J.R. Smith
 - c. Wade
 - d. Zurn
 - e. Or approved equivalent.
2. Piston Type:
 - a. PPP
 - b. Sioux Chief
 - c. Or approved equivalent.

D. Trap Primers:

1. Wade
2. Zurn
3. J.R. Smith
4. PPP
5. Or approved equivalent.

2.2 PRESSURE GAUGES

A. Pressure Gauges: ASME B40.100, phosphor-bronze bourdon type, dry type.

1. Case: Cast aluminum, stem-mounted, flange less.
2. Size: 4-1/2-inch diameter.
3. Window: Clear glass.
4. Connector: Brass.
5. Scale: White aluminum with black graduation and markings.
6. Pointer: Black, adjustable.
7. Mid-Scale Accuracy: One percent.
8. Scale: PSI and KPa.
9. Basis of Design: Trerice Model 600CB.

2.3 THERMOMETERS

A. Thermometers - Adjustable Angle: Red or blue appearing organic liquid in glass, ASTM E 1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

1. Size: 9-inch scale.
2. Window: Acrylic.
3. Scale: Aluminum, white background, black graduations and markings.
4. Stem: 3/4-inch NPT brass (aluminum for installation in air ducts).
5. Accuracy: 2 percent, per ASTM E 77.
6. Calibration: 0-160 with 2 Degrees F graduations.
7. Basis of Design: Trerice BX9.

2.4 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

- A. Bellows-type, stainless steel casing and bellows, pressure rated, tested and certified in accordance with PDI WH-201.
- B. Piston-type, copper, brass or stainless steel with O-ring piston, pressure rated, tested and certified in accordance with PDI WH-201.

2.5 TRAP PRIMERS

- A. Trap seal automatic primer valve with integral anti siphon protection. Code approval required.
- B. Electronic trap seal automatic primer valve with integral anti siphon protection tied to DDC system. Coordinate quantity, locations and voltage characteristics for control points and with Section "Controls."
- C. Trap seal primer valve (low lead) with integral automatic anti-siphon protection. The priming valve to discharge on both pressure drop and pressure spike. PPP CPO 500.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. For Plumbing Devices requiring access from access panels (i.e. trap primers, water hammer arrestors and the like) submit location/size of all access panels to architect for approval prior to purchase and installation of access panel. See Section 22 00 00, General Plumbing Requirements for additional requirements.
- B. Temperature Gauges:
 - 1. Install in vertical upright position, tilted so as to be easily read at floor.
 - 2. Thermometer Wells: Install in piping in vertical upright position. Fill well with oil or graphite, secure cup.
- C. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- D. Install per manufacturer recommendations.

3.2 PRESSURE GAUGES

- A. Install pressure gauge where exposure to heat and vibration are minimal and where the dial can be easily read. It is also important to install the gauge in a location with undisturbed and continuous flow of the pressure medium.
- B. Provide a needle valve or gauge cock, installed between the process and the pressure gauges.
- C. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position, visible from floor.
- D. Locations: Install in the following locations, and elsewhere as indicated.
 - 1. At each pump inlet and outlet.
 - 2. At inlet and discharge of each pressure reducing valve.
 - 3. At make-up water service outlets.
- E. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- F. Pressure Gauge Range/Graduations:

System	Pressure (PSI)	Graduations (PSI)
Cold Water	0-100	1
Hot Water	0-100	1
Compressed Air	0-160	1

- G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- H. Install per manufacturer recommendations.

3.3 THERMOMETERS

- A. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2-inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- B. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- C. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- D. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- E. Thermometer Range/Graduations:

System	Temperature (Degrees F)	Graduations (Degrees F)
Cold Water	25-125	1
Hot Water	30-240	2

- F. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- G. Install per manufacturer recommendations.

3.4 WATER HAMMER ARRESTORS (SHOCK ABSORBERS) - BELLOWS AND PISTON TYPE

- A. Locate shock absorbers in supply pipe in accordance with recommendations of Plumbing and Drainage Institute PDI-WH201. Install ahead of solenoid operated valves. Determine size of absorber by fixture unit value of fixture supplied, using PDI symbols to designate sizes. Provide access panel for each shock absorber.
- B. Water Hammer Arrestors: Install in upright position, in locations and of sizes in accordance with PDI WH-201, and elsewhere as indicated
- C. Install per manufacturer recommendations.

3.5 TRAP PRIMERS

- A. Flush supply line prior to installation.
- B. Install valve plumb using caution to not over tighten. Tightening to more than 55 ft. lbs. can damage valve and void the warranty. Do not wrench on hex.
- C. Effective operating range 20 to 80 PSIG (138 to 552 kpa).
- D. Do not subject trap primer valve to pressure in excess of 125 PSI.
- E. Failure to follow these instructions will make the product warranty null and void.

END OF SECTION

**SECTION 220523
GENERAL-DUTY VALVES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Valves, General
 - 2. Balancing Valves
 - 3. Ball Valves
 - 4. Swing Check Valves
 - 5. Wafer Check Valves
 - 6. Lift Check Valves
 - 7. Backflow Prevention Assemblies
 - 8. Pressure Regulating Valve-Domestic Water
 - 9. Thermostatic Master Mixing Valves (ASSE 1017 Rated)

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. NSF 61, Annex G and/or NSF/ANSI 372 for potable water services. Valves must be 3rd party certified.
 - 2. ISO 9001 Certified.
 - 3. IAPMO Certified for Low Lead.
- C. Source Limitations for Valves: Obtain each type of valve from a single source and from a single manufacturer.
- D. Model numbers indicated as Basis-of-Design indicate valve characteristics. All valves are to meet code Low Lead/Lead Free Standards.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Valves: Obtain each type of valve from a single source and from a single manufacturer.
- B. Valves, General:
 - 1. Apollo
 - 2. Armstrong
 - 3. ASCO
 - 4. Cla-Val
 - 5. Conbraco
 - 6. Crane
 - 7. Clow
 - 8. Griswold
 - 9. Hammond
 - 10. Hays
 - 11. Jenkins
 - 12. Josam
 - 13. Kennedy
 - 14. Milwaukee
 - 15. Mueller
 - 16. Nibco
 - 17. Red-White Valve
 - 18. Smith
 - 19. Stockham
 - 20. Tour Anderson
 - 21. Wade
 - 22. Watts
 - 23. Wilkins
 - 24. Zurn
 - 25. Or approved equivalent.
- C. Balancing Valves:
 - 1. Griswold
 - 2. Hays
 - 3. Armstrong CBV
 - 4. Tour Anderson
 - 5. Or approved equivalent.
- D. Ball Valves:
 - 1. See Valves General above.
 - 2. NSF Valves:
 - a. Clow
 - b. Kennedy
 - c. Nibco
 - d. Or approved equivalent.
- E. Swing Check Valves:
 - 1. See Valves General above.

- F. Wafer Check Valves:
 - 1. See Valves General above.
- G. Lift Check Valves:
 - 1. See Valves General above.
- H. Backflow Prevention Assemblies:
 - 1. Backflow Preventers:
 - a. Apollo
 - b. Cla-Val
 - c. Conbraco
 - d. Watts
 - e. Or approved equivalent.
 - 2. Backflow Prevention Assemblies - Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications - 2-inches and Smaller:
 - a. Febco 860-with 650A.
 - b. Conbraco 40-210-AGD.
 - c. Wilkins 375-XL-SAG.
 - d. Watts 919-QT-S valve with 919AGC or 919AGF.
 - e. Or approved equivalent.
 - 3. Backflow Prevention Assemblies - 2-1/2-inches and Larger:
 - a. Febco 860 with 758A.
 - b. Conbraco Apollo 40-700 with 758A.
 - c. Watts 909-S-NFA-NRS with AGC.
 - d. Wilkins 375-FSC.
 - e. Or approved equivalent.
 - 4. Backflow Prevention Assemblies - Double Check Valve Assembly (DCVA) for Low Hazard Applications - 2-inches and smaller:
 - a. Febco 850-650A
 - b. Conbraco Apollo 40-110-T2
 - c. Watts 007-QT-FDA-S
 - d. Wilkins 350-S-XL
 - e. Or approved equivalent.
 - 5. Backflow Prevention Assemblies - Double Check Valve Assembly (DCVA) for Low Hazard Applications - 2-1/2-inches and larger:
 - a. Conbraco Apollo 45-11-1
 - b. Watts 709-DCDA with 77F-01-FDA-12
 - c. Or approved equivalent.
 - 6. Spill Resistent Pressure Vacuum Breaker:
 - a. Febco
 - b. Conbraco
 - c. Watts
 - d. Wilkins
 - e. Or approved equivalent.
 - 7. Atmospheric Vacuum Breakers:
 - a. Febco
 - b. Conbraco
 - c. Watts
 - d. Wilkins
 - e. Or approved equivalent.
- I. Pressure Regulating Valve-Domestic Water:
 - 1. Cash Acme
 - 2. Cla-Val
 - 3. Watts
 - 4. Wilkins

5. Or approved equivalent.
- J. Thermostatic Master Mixing Valves (ASSE 1017 Rated):
1. Holby Tempering Valve
 2. Lawler Series 66
 3. Leonard Type TM
 4. Powers LFMM430 (Lead Free)
 5. Symmons Temp Control Series 5
 6. Or approved equivalent.

2.2 VALVES - GENERAL

- A. General:
1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
 2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6-inches and smaller. Provide gear operators for quarter-turn valves 8-inches and larger and plug valves installed over 5-feet above finished floor.
 3. Valve Identification: Manufacturer's name (or trademark) and pressure rating clearly marked on valve body.
- B. Valves in Insulated Piping: With 2-inch stem extension and following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation on valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied.
- C. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Solder Joint: With sockets according to ASME B16.18.
 3. Threaded: With thread according to ASME B1.20.1.
- D. Valve Bypass and Drain Connections: MSS SP-45.
- E. Building Service:
1. Shutoff and Isolation Valves:
 - a. Pipe Sizes 3-inches and Smaller: Ball Valve.
 2. Drain Service: Ball valves.
 3. Strainer Blow-Off: Ball Valve.
 4. Check Valves: Swing, Wafer, or Lift.

2.3 BALANCING VALVES

- A. Maximum 125 PSIG System Working Water Pressure.
- B. Manual Set Balancing Valves:
1. Valves are to be of the "Y" pattern, equal percentage globe-style and provide three functions:
 - a. Precise flow measurement.
 - b. Precision flow balancing.
 - c. Positive drip-tight shut-off.
 2. Valve to provide multi-turn, 360 degree adjustment with micrometer type indicators located on the valve handwheel. Valves have a minimum of five full 360 degree handwheel turns. 90 degree circuit-setter style ball valves are not acceptable. Valve handle to have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. Valves to be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi to have two 1/4-inch threaded brass metering ports with check valves and gasketed caps located on the inlet side of

the valve. Valves to be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug to be brass. The handwheel to be high-strength resin.

2.4 BALL VALVES

- A. All ball valves on brazed piping are to be three-piece.
- B. 2-1/2-inches and Smaller: MSS SP-110, 400-600 PSI, two-piece full port ball configuration, bronze body, extended soldered ends for copper pipe and threaded ends for iron pipe, brass or stainless steel ball, Teflon seat or brass stem. Apollo 70CLF 100 Series two-piece.
- C. 3-inches and Larger: MSS SP-110, 400-600 PSI, three-piece full port ball configuration, bronze body, extended soldered ends for copper pipe and threaded ends for iron pipe, brass or stainless steel ball, Teflon seat, brass stem, or extended steel handle. Apollo 82-100/82A 140 Series three-piece.
- D. Full Port Ball Valve: 2- to 4-inch ductile iron, ASTM A536, micro finish steel chrome plated or stainless steel ball and stem. TFE seats, 600 PSI.

2.5 SWING CHECK VALVES

- A. 2-inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413. MSS SP-80.
- B. 2-1/2-inches and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Nibco F918. MSS SP-71.
- C. Rubber Flapper Check Valve: Horizontal or vertical upward flow installation. Working pressure to 175 PSI. Ductile iron or cast iron body. Steel reinforced Buna-N rubber flapper epoxy coating on wetted parts. MSS SP-80.

2.6 WAFER CHECK VALVES

- A. 2-inches and larger, Class 125, lead free, cast iron.
- B. Disk with renewable bronze disks.
- C. Body spring loaded wafer style check valve twin.
- D. 200 psi rated maximum temperature 180 Degrees F., ANSI B16d, NSF/ANSI 61 and 372.
- E. Nibco W-920-W-LF

2.7 LIFT CHECK VALVES

- A. 3-inches and Smaller: Bronze body, 125 PSI, spring loaded, Teflon seat. Steam Service, Teflon Disc: Apollo CYB-LF (Lead Free). Water, Gas or Oil Service, Buna-N Disc: MSS SP-80.
- B. 4-inches and Larger: Stainless or bronze body, 125 PSI, spring loaded, silent check, bronze, stainless steel or TFE seat and disc. 125 PSI Valmatic Series 1800.

2.8 BACKFLOW PREVENTION ASSEMBLIES

- A. General: Assemblies model numbers listed below are for general comparison. Project specific model numbers to be verified contractor as approved by jurisdiction where project is located.
- B. Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications:
 - 1. 2-inches and Smaller: Assembly consists of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and pressure-differential relief valve located between two positive seating check valves and comply with requirements of ASSE Standard 1013 and

AWWA C511. Bronze construction, threaded ends, stainless steel internal parts, FDA strainer, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.

2. 2-1/2-inches and Larger: Assembly consists of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and pressure-differential relief valve located between two positive seating check valves and comply with requirements of ASSE Standard 1015 and AWWA C511. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and FDA strainer.

- C. Spill Resistant Pressure Vacuum Breaker: Watts Model 800MCQT with 777S "Y" strainer.
- D. Atmospheric Vacuum Breaker: Assembly consists of a bronze vacuum breaker body with silicone disc, and full size orifice. Device to be IAPMO listed, meet ASSE standard 1001, and ANSI standard A113.1.1 rough chrome plate finish.

2.9 PRESSURE REGULATING VALVE-DOMESTIC WATER

- A. Water: Bronze body, diaphragm or piston type, spring actuated, with separate or integral stainless steel strainer, pressure range to suit conditions, approved for potable water use, low lead. Provide shutoff valves, pressure relief valves, unions, drain valve and bypass.
- B. Water: Automatic control pressure regulating valve, stainless steel seat, stem and spring, diaphragm actuated with brass body, hydraulic control pilots with effluent operating temperature range 32 degrees F to 180 degrees F, FDA and AWWA approved.
- C. Water: Bronze body construction, stainless steel strainer screen, thermal expansion bypass with renewable stainless steel seat and high temperature resisting diaphragm.

2.10 THERMOSTATIC MASTER MIXING VALVES (ASSE 1017 RATED)

- A. Thermostatic type with bronze body construction, corrosion resistant, materials, union end stops, check inlets with strainers, 0-200 degree fahrenheit dial thermometer and discharge shut-off valve. Mixing valves to meet ASSE 1017.
- B. Maximum required delta temperature differential between hot water supply temperature and delivery temperature is 15 degrees F. Set valve outlet temperature per drawing requirements.
- C. Flow from the tempered water circulating pump to be split to mixing valve and building hot water heating system.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Prepare valves for shipping as follows:
 1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves and weld ends.
 3. Set ball valves open to minimize exposure of functional surfaces.
 4. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Do not attempt to repair defective valves; replace with new valves.

- E. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate Sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
- F. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter and cap on chain for each valve that must be installed with stem below horizontal plane. Ensure installation provides full stem movement.
- G. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.
- H. Mechanical Actuators: Install with chain operators where indicated. Extend chains to 5-feet above floor and hook to clips to clear aisle passage.
- I. Stem Selection: Outside screw and yoke stems, except provide inside screw, non-rising stem where space prevents full opening of OS&Y valves.
- J. Seats: Renewable seats, except where otherwise indicated.
- K. Installation of Check Valves:
 - 1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow. Only install where there are 10 pipe diameters of straight pipe upstream of valve.
 - 2. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow.
 - 3. Lift Check Valves: Install in piping line with stem vertically upward, position for proper direction of flow.
- L. Balancing Valves: Install with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream from the balancing valve should be free of any fittings. When installed, easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided. Mounting of valve in piping must prevent sediment build-up in metering ports.
- M. When soldering, use paste flux that are approved by the manufacturer for use with lead free alloys.
- N. If valve applications are not indicated on Drawings, use the following:
 - 1. Shutoff Service: Ball.
- O. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- P. Valves, except wafer types, with the following end connections.
 - 1. For Copper Tubing, 2-inches and Smaller. Threaded ends except where solder-joint valve-end.
 - 2. For Copper Tubing, 2-1/2-inches to NPS 4-inches. Flanged ends except where threaded valve-end.
 - 3. For Steel Piping, 2-inches and Smaller: Threaded ends.
 - 4. For Steel Piping, 2-1/2-inches to NPS 4-inches: Flanged ends except where threaded valve-end.
- Q. Valve Adjusting and Cleaning:
 - 1. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.
 - 2. Valve Identification. Tag valves per Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.2 BALANCING VALVES

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations
- C. Purge and clean all piping to be connected to valve.
- D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.
- E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.
- F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.

3.3 BALL VALVES

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations
- C. Purge and clean all piping to be connected to valve.
- D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.
- E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.
- F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.

3.4 SWING CHECK VALVES

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations
- C. Purge and clean all piping to be connected to valve.
- D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.
- E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.
- F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.
- G. Ejector and Sump Pump-Discharge Check Valves:
 - 1. 2-inches and Smaller: Bronze swing or spring-loaded lift check valves with bronze disc.

2. 2-1/2-inches and Larger: Rubber flapper swing check valves with lever and weight.

H. Domestic Water and Circulation Pump Discharge Check Valves:

1. 2-inches and Smaller: Bronze body, spring loaded, lead free, lift check.

2. 2-1/2-inches and Larger: Wafer style, silent lift check valve, lead free.

3.5 WAFER CHECK VALVES

A. See General Installation Requirements above.

B. Install per manufacturers recommendations

C. Purge and clean all piping to be connected to valve.

D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.

E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.

F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.

G. Domestic Water and Circulation Pump Discharge Check Valves:

1. 2-1/2-inches and Larger: Wafer style, silent lift check valve, lead free.

3.6 LIFT CHECK VALVES

A. See General Installation Requirements above.

B. Install per manufacturers recommendations

C. Purge and clean all piping to be connected to valve.

D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.

E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.

F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.

G. Ejector and Sump Pump-Discharge Check Valves:

1. 2-inches and Smaller: Bronze swing or spring-loaded lift check valves with bronze disc.

2. 2-1/2-inches and Larger: Rubber flapper swing check valves with lever and weight.

H. Domestic Water and Circulation Pump Discharge Check Valves:

1. 2-inches and Smaller: Bronze body, spring loaded, lead free, lift check.

2. 2-1/2-inches and Larger: Wafer style, silent lift check valve, lead free.

3.7 BACKFLOW PREVENTION ASSEMBLIES

A. See General Installation Requirements above.

- B. Install per manufacturers recommendations
- C. Purge and clean all piping to be connected to valve.
- D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.
- E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.
- F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.
- G. Install where indicated, and where required by code. Where practical, locate in same room as equipment being protected.
- H. Submit product cut sheets to local AHJ for approval prior to purchase and installation.
- I. Install as close to wall as possible with clearances for access and maintenance as required by AHJ.
- J. Coordinate exact location of installation and type of backflow device serving a particular piece of equipment with AHJ and Architect prior to purchase and installation.
- K. Provide wall/floor brackets that are of fully welded, hot dipped galvanized construction, fabricated to meet field conditions. Mount backflow preventer to brackets using cadmium plated "U" type bolts and nuts.
- L. Contact: Contact local water district/backflow specialist and request backflow installation requirements. Install backflow devices per UPC and local water district/backflow specialist requirements.
- M. Route waste piping from air gap waste fitting concealed within walls to point of air gap termination at indirect waste receptor.
- N. Follow local codes for installation requirements. Pipe lines should be thoroughly flushed to remove foreign material before installing the unit. Provide a strainer ahead of backflow preventer to prevent disc from unnecessary fouling. Install valve inline with arrow on valve body pointing in the direction of flow. It is important that the valve be easily accessible to facilitate testing and servicing. Do not install in a concealed location.

3.8 PRESSURE REGULATING VALVE-DOMESTIC WATER

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations
- C. Purge and clean all piping to be connected to valve.
- D. Install valve in the line with arrow on valve body pointing in the direction of flow. This valve should be installed where it is accessible with sufficient clearance for cleaning, service or adjustment. Install the reducing valve when possible before before a sill cockline if possible. Before installing the reducing valve hose bibb, flush out the line to remove loose dirt and cale which might damage valve disc and seat.
- E. Horizontal installation is recommended. However, valve can be installed in a vertical position. Regulator must be installed in an accessible location to facilitate servicing the regulator.
- F. To readjust reduced pressures, loosen adjusting screw nut and turn adjusting screw clockwise to raise reduced pressure and counterclockwise to lower reduced pressure.

- G. When reducing valve is used, it makes a closed system; therefore, pressure relief protection must be provided on the downstream side of the reducing valve to protect equipment.
- H. Provide pressure relief valve and terminate discharge to indirect waste receiver.
- I. Anytime a reducing valve is adjusted, the use of a pressure gauge is recommended to verify correct pressure setting. Do not bottom out adjusting screw or spring cage.
- J. Provide inlet and outlet ball valves bypass. Provide pressure gauge on valve outlet.
- K. Provide pressure relief valve piped full size to indirect waste receiver or floor drain.
- L. Provide factory startup on automatic control valves.

3.9 THERMOSTATIC MASTER MIXING VALVES (ASSE 1017 RATED)

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations
- C. Purge and clean all piping to be connected to valve.
- D. Install mixing valve per manufacturer's instruction manual.

END OF SECTION

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
1. Pipe Hangers and Supports for Plumbing Piping and Equipment
 2. Wall and Floor Sleeves
 3. Building Attachments
 4. Flashing
 5. Miscellaneous Metal & Materials

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
1. ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.
 2. Hanger spacing installation and attachment to meet all manufacturers requirements and Code requirements.
 3. Terminology: As defined in MSS SP-90 "Guidelines on Terminology for Pipe Hangers and Supports".
 4. Install piping per SMACNA's requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
1. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 2. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
 - a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.
 3. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems whose products have been in satisfactory use in similar service for not less than 10 years.
 4. Support systems to be supplied by a single manufacturer.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.7 PERFORMANCE REQUIREMENTS

- A. General - Provide pipe and equipment hangers and supports in accordance with the following:
 - 1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor is responsible for their design.
 - 2. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
- B. Engineered Support Systems:
 - 1. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
 - 2. Equipment and piping support frame anchorage to supporting slab or structure.
- C. Provide channel support systems, for piping to support multiple pipes capable of supporting the combined weight of supported systems, system contents and test water.
- D. Provide heavy-duty steel trapezes for piping to support multiple pipes capable of supporting the combined weight of supported systems, system contents and test water.
- E. Provide seismic restraint hangers and supports for piping and equipment. See Section 220548.
- F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment. See Section 220548.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pipe Hangers and Supports for Plumbing Piping and Equipment:
 - 1. Pipe Hangers/Supports:
 - a. B-Line Systems, Inc.
 - b. Anvil International
 - c. HOLDRITE
 - d. Erico Co., Inc.
 - e. Rilco Manufacturing Co. Inc.
 - f. Nelson-Olson Inc.
 - g. Or approved equivalent.
 - 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Anvil International, Anvit-Strut
 - c. Erico Hanger Co., Inc.; O-Strut Div.
 - d. Unistrut Corp.
 - e. HOLDRITE EZ-Strut Systems
 - f. Or approved equivalent.
 - 3. Thermal-Hanger Shield Inserts:
 - a. Erico Hanger Co., Inc.
 - b. Pipe Shields, Inc.
 - c. Rilco Manufacturing Co., Inc.
 - d. HOLDRITE Insulation Couplings
 - e. Or approved equivalent.
 - 4. Freestanding Roof Supports:
 - a. Erico Hanger Co., Inc.

- b. Nelson-Olsen Inc.
 - c. B-Line
 - d. M. Fab
 - e. Or approved equivalent.
5. Pipe Alignment and Secondary Supports:
- a. HOLDRITE
 - b. Starquick
 - c. Or approved equivalent.
- B. Wall and Floor Sleeves:
- 1. Below Grade and High Water Table Areas:
 - a. Modular Link Sealing System at Pipe Sleeves:
 - 1) Thunderline Corporation
 - 2) Or approved equivalent.
 - 2. Pre-Engineered Firestop Pipe Penetration Systems:
 - a. HOLDRITE HydroFlame
 - b. Proset
 - c. Or approved equivalent.
- C. Building Attachments:
- 1. Anchor-It
 - 2. Gunnebo Fastening Corp.
 - 3. ITW Ramset/Red Head
 - 4. Masterset Fastening Systems, Inc.
 - 5. Or approved equivalent.
- D. Flashing:
- 1. Fastenal
 - 2. Or approved equivalent.
- E. Miscellaneous Metal & Materials:
- 1. See Miscellaneous Metal & Materials article below.

2.2 PIPE HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

- A. Horizontal Piping Hangers and Supports - Horizontal and Vertical Piping, and Hanger Rod Attachments:
- 1. Factory fabricated horizontal piping hangers and supports to suit piping systems in accordance manufacturer's published product information.
 - 2. Use only one type by one manufacturer for each piping service.
 - 3. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation with saddle or shield for insulated piping.
 - 4. Provide copper-plated hangers and supports for uninsulated copper piping systems.
 - 5. Provide padded pipe hangers, clamps and supports for thermoplastic piping system.
 - 6. Install no hub cast iron pipe and fittings per CISPI 301-09 Installation Procedures for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain Waste and Vent Piping Applications. Brace hubless cast iron pipe and fittings 5-inch and larger with HOLDRITE No Hub Pipe Restraints or approved equivalent.
- B. Pipe Hangers, Guides and Channel Systems:
- 1. Hanger Rods: Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.
 - 2. Hanger Rod Couplings: Malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.

3. Pipe Rings for Hanger Rods: Pipe sizes 2-inch and smaller, MSS SP Type 6 or Type 10, or approved equivalent. Pipe sizes 2-1/2-inches and larger, clevis type hangers with adjustable nuts on rod. MSS SP Type 1. Pipe rings to have same finish as hanger rods.
 4. Pipe Slides: Type 35 reinforced Teflon slide material (3/32-inch minimum thickness) bonded to steel; highly finished steel or stainless steel contact surfaces to resist corrosion; 60-80 PSI maximum active contact surface loading; steel parts 3/16-inch minimum thickness; attachment to pipe and framing by welding.
 5. Pipe Guides:
 - a. Furnish and install pipe guides on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides securely to pipe and structure. Any contact with chilled water pipe is not to permit heat to be transferred in sufficient quantity to cause condensation on any surface.
 - b. Furnish and install guides approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Guides are not to be used as supports and are in addition to other pipe hangers and supports.
- C. Pipe Saddles and Shields:
1. Factory fabricated saddles or shields under piping hangers and supports for insulated piping.
 2. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12-inches in length (4-inch pipe and larger to be three times longer than pipe diameter).
- D. Thermal-Hanger Shield Inserts: 100-PSI (690-kPa) minimum compressive strength insulation, encased in sheet metal shield.
1. Material for Cold Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with vapor barrier.
 2. Material for Hot Piping: Water-repellent-treated ASTM C533, Type 1 calcium silicate.
 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 4. For Clevis or Band Hanger: Insert and shield to cover lower 180 degrees of pipe.
 5. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.
 6. Thermal Hanger Shield Inserts should be provided at the hanger points and guide locations on pipes requiring insulation. The Inserts should consist of Polyisocyanurate (urethane or phenolic insulation) encircling the entire circumference of the pipe with a 360 degree PVC (1.524 mm thick) with a living hinge and J lock and installed during the installation of the piping system.
- E. Roller Hangers:
1. Adjustable roller hanger. Black steel yoke, cast iron roller. MSS Type 41.
- F. Concrete Inserts:
1. Malleable iron body, hot dipped galvanized finish. Lateral adjustment. MSS Type 18.
- G. Continuous Concrete Insert:
1. Steel construction, minimum 12 gauge. Electro galvanized finish. Pipe clamps and insert nuts to match.
- H. Beam Clamps:
1. MSS Type 19 and 23, wide throat, with retaining clip.
 2. Universal Side Beam Clamp: MSS Type 20.
- I. Below Ground:
1. Pipe Hangers: Adjustable Clevis type, Federal Specification WW-H-171 (Type 1), UL listed, stainless steel Type 316. MSS Type 1. If PVC piping to be used, provide Type 1 hanger, coated for PVC piping.
 2. Rod: 5/8-inch stainless steel Type 316.

3. Eyebolt: Stainless steel Type 316.
 4. Nuts and Washers: Stainless steel Type 316.
- J. Hangers for Pipe Size 2-inches and Smaller:
1. Adjustable swivel ring hanger, UL listed, Type 6 or Type 10.
- K. Hangers for Pipe Size 2-1/2-inches and Larger:
1. Adjustable clevis type, UL listed, Type 1.
- L. Riser Clamps:
1. Steel, UL listed. MSS Type 8.
- M. Plumbers Tape:
1. Not permitted as pipe hangers or pipe straps.
- N. Pipe Alignment and Secondary Support Systems:
1. Secondary Pipe supports for general applications (Non-Acoustical).
 - a. Supports will be manufactured in compliance with IAPMO Product Standard PS 42-96. All products provided will be listed by IAPMO for secondary pipe support.
 - b. Supports may be used when sound and/or vibration transfer is not a concern.
 2. Secondary pipe supports for sound and vibration attenuation (Acoustical).
 - a. Supports will be manufactured in compliance with IAPMO Product Standard PS 42-96. All products provided will be listed by IAPMO for secondary pipe support.
 - b. Acoustical pipe supports will be manufactured and installed in compliance with International Organization for Standardization (ISO) 3822-1 with current amendments.
 - c. Supports will be used when sound and/or vibration transfer is a concern. Locations where acoustical supports will be provided and include but are not limited to partition walls between living units, tenant spaces, retail units, mechanical rooms and lobbies.
 - d. Support Products:
 - 1) Support to Wall Brace and Wall Stud Penetrations: HOLDRITE #261, #262, #263, and #264, or approved equivalent.
 - 2) Pipe Wrap for Pipe Clamps and Channel-Mounted Pipe Clamps: HOLDRITE #270, or approved equivalent.
 - 3) Pipe Wrap for Pipe Hangers: HOLDRITE #271, #272-2, and #272-4, or approved equivalent.
 - 4) Drop-Ear Fitting Support: HOLDRITE #265, or approved equivalent.
 - 5) Floor Riser Isolation Pads: HOLDRITE #275-T, or approved equivalent.
 - 6) Floor Isolation Pads (General Applications): HOLDRITE #274, #275, #276, and #278, or approved equivalent.
- O. Freestanding Roof Pipe Supports:
1. Polyethylene high-density U.V. resistant quick "pipe" block with foam pad.
 2. Recommended installation is for pipe blocks to be freestanding.
 3. Piping 3-inches and larger mounted on block type supports.

2.3 WALL AND FLOOR SLEEVES

- A. Below Grade and High Water Table Areas:
1. Modular Link Sealing System at Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Use a modular link sealing system at sleeves to continuously fill the annular space between the pipe and the wall opening. Provide Link-seal Type C unless otherwise noted. OS with S-316 stainless construction for continuous water/tank walls.
 2. Sleeves through concrete foundation walls and floors. Ductile iron pipe. Class 50 or 51 pipe conforming to ANSI/AWWA C151/A21.51, cement lined. Pipe sleeve will extend a minimum of 6-inches beyond outside perimeter of foundation. Final placement of sleeve will be confirmed with project's structural engineer. In areas with a high water table, provide AWWA C900, Class 235 plastic pipe in lieu of ductile iron pipe.

- B. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.
- C. Insulating Caulking: Eagle or Pitcher Super 66 high temperature cement.
- D. Fabricated Accessories:
 - 1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
 - 2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide following minimum gauges for sizes indicated:
 - a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.
 - b. Sleeve Sizes 5-inches to 6-inches: 16 gauge.
 - c. Sleeve Sizes 7-inches and Larger: 14 gauge.
 - d. Fire-Rated Safing Material:
 - 1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 lbs./cu.ft. density with melting point of 1985 Degrees F and K value of 0.24 at 75 Degrees F.
 - 2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100 Degrees F to 1200 Degrees F service with K value of 0.40 at 150 Degrees F.

2.4 BUILDING ATTACHMENTS

- A. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project Structural Engineer. Provide anchor bolts suitable for cracked concrete.
- B. Anchor Bolts:
 - 1. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
 - 2. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
 - 3. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.
- C. Building Attachments:
 - 1. Beam Clamps:
 - a. MSS Type 19 and 23, wide throat, with retaining clip.
 - b. Universal Side Beam Clamp: MSS Type 20.
 - 2. Anchor Bolts:
 - a. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer. Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
 - b. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
 - c. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
 - d. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.
 - 3. Building Attachments:
 - a. Factory fabricated attachments to suit building substructure conditions and in accordance with manufacturer's published product information.
 - b. Select size of building attachments to suit hanger rods.
 - 4. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

5. Grout: ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - a. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - b. Properties: Nonstaining, noncorrosive, and non-gaseous.
 - c. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

2.5 FLASHING

- A. Steel Flashing: 26 gauge galvanized steel.
- B. Safes: 8 mil thick neoprene.
- C. Caps: Steel, 22 gauge minimum, 16 gauge at fire-resistant structures.
- D. Provide galvanized components for items exposed to weather.

2.6 MISCELLANEOUS METAL AND MATERIALS

- A. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on Drawings or otherwise not shown on drawings, that are necessary for completion of the project. The Contractor is responsible for their design.
 1. Fabricate miscellaneous units to size, shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.
- B. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.
- C. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.
- D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.
- E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.
- F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods and equipment required for fabrication.
- G. Provide hot dipped galvanized components for items exposed to weather.
- H. Use straps, threshold rods and wire with sizes required by SMACNA to support ductwork.
- I. Grout: ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 2. Properties: Nonstaining, noncorrosive, and non gaseous.
 3. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Examination:
 - 1. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.
- B. Preparation:
 - 1. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.
- C. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate with project structural engineer proper placement of inserts, anchors and other building structural attachments.

3.2 PIPE HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

- A. Hangers and Supports:
 - 1. Comply with MSS SP-58. Pipe Hanger and Support Installation: Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. For horizontally hung grooved-end piping, provide a minimum of 2 hangers per pipe Section.
 - 2. Pipe Ring Diameters:
 - a. Uninsulated and Insulated Pipe, except where oversized pipe rings are specified: Ring inner diameter to suit pipe outer diameter.
 - b. Insulated Piping Where Oversized Pipe Rings are Specified and Vibration Isolating Sleeves: Ring inner diameter to suit outer diameter of insulation or sleeve.
 - 3. Oversize Pipe Rings: Provide oversize pipe rings of 2-inch and larger size.
 - 4. Pipe Support Brackets: Support pipe with pipe slides.
 - 5. Steel Backing in Walls: Provide steel backing in walls to support fixtures and piping hung from steel stud walls.
 - 6. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 - a. Field assemble and install according to manufacturer's written instructions.
 - 7. Pipe Guides:
 - a. Install on continuous runs where pipe alignment must be maintained. Provide a minimum of two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides to pipe structure. Any contact with chilled water pipe should not permit heat to be transferred in sufficient quantity to cause condensation on any surface.
 - b. Install approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Do not use as supports. Provide in addition to other required pipe hangers and supports.
 - 8. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field -fabricated, heavy-duty trapezes.
 - a. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - b. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1
 - 9. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers.
 - 10. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe.
 - 11. Do not support piping from other piping.

12. Fire protection piping will be supported independently of other piping.
13. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.
14. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.
15. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchor, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
16. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
17. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping" is not exceeded.
18. Insulated Piping: (comply with the following)
 - a. Attach clamps and spacers to piping.
 - 1) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - 2) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 3) Do not exceed pipe stress limits according to ASME B31.9.
 - b. Install MSS SP-58, Type 39 protection saddles, if insulation without a vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
 - c. Install MSS SP-58, Type 40 protective shields on cold piping having a vapor barrier. Shields to span arc of 180 degrees.
 - 1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
 - d. Shield Dimensions for Pipe, not less than the following:
 - 1) NPS 1/4 to NPS 3-1/2 (DN8 to DN 90): 12-inches long and 0.048-inch thick.
 - 2) NPS 4 (DN100): 12-inches long and 0.06-inch thick.
 - 3) NPS 5 and NPS 6 (DN125 and DN150): 18-inches long and 0.06-inch thick.
 - 4) NPS 8 to NPS 14 (DN200 to DN350): 24-inches long and 0.075-inch thick.
 - 5) NPS 16 to NPS 24 (DN400 to DN600): 24-inches long and 0.105-inch thick.
 - e. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
 - f. Insert Material: Length at least as long as protective shield.
 - g. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
19. Equipment Clearances: Do not route ductwork, equipment, or piping through electrical rooms, transformer vaults, elevator equipment rooms, IT rooms, MPOE rooms, or other electrical or electronic equipment spaces and enclosures and the like. Within equipment rooms, provide minimum 3-feet lateral clearance from all sides of electric switchgear panels. Do not route piping or equipment above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact ductwork, equipment or pipe routing to provide proper clearance with such items.
20. Pipe supports and hanger spacing (pipe supported from structure or floor-supported) to meet the requirements of References and Standards Article in Part 1 above.
21. Channel Type Pipe Hanging System: Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33, one side of channel to have a continuous slot with in turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.

B. Pipe Curb Assemblies:

1. Provide prefabricated units for roof membrane and insulation penetrations related to equipment. Coordinate with roofing system. Set supports on the structural deck. Do not set supports on insulation or roofing. Provide level supports by prefabricated pitch built into the curb.

2. Pipe Curb Assemblies: Provide for piping and electrical conduit which penetrates the structural roof deck to service equipment above the roof level (i.e., piping, electrical power and control wiring). Meet requirements of roof warranty.
 3. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise. At roofing applications, the adhesion mastic is to be specifically submitted to and approved by the roofing system manufacturer/installer to maintain the integrity of all warranties.
 4. At concrete floors, install a polyurethane mastic to the support block and adhere in place.
- C. Vertical Piping:
1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
 2. Riser clamps to be directly under fitting or welded to pipe. Provide neoprene pads for all systems except natural gas.
 3. Riser to be supported at each floor penetration.
 4. Provide structural steel supports at the base of pipe risers. Size supports to carry forces exerted by piping system when in operation.
- D. Adjusting and Painting:
1. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping and equipment to proper level and elevations.
 2. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

3.3 WALL AND FLOOR SLEEVES

- A. "Link-Seal" Pipe Sleeves: Install at slab on grade floor/below grade piping penetrations. Provide manufacturer's sleeve appropriate to seal type for pre-cast penetrations (except for DWV piping at slab on grade). Provide manufacturer's sleeve appropriate to seal type for pre-cast penetrations.
- B. Fabricated Pipe Sleeves:
1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeve diameter to be determined by local seismic clearance requirement, and by waterproofing requirements.
 2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1-inch above floor finish.
 3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
 4. Seal each end airtight with a resilient nonhardening sealer, UL listed and fire rated per ASTM 814.

3.4 BUILDING ATTACHMENTS

- A. Anchor Bolts:
1. General: Install anchor bolts for mechanical equipment, piping and ductwork as required. Tightly fit and clamp base-supported equipment anchor bolts at equipment support points. Provide locknuts where equipment, piping and ductwork are hung.
 2. Anchor bolts (Cast-In-Place): Embed anchor bolts in new cast-in-place concrete to anchor equipment. Install a pipe sleeve around the anchor bolt for adjustment of the top 1/3 of the bolt embedment; sizes and patterns to suit the installation conditions of the equipment to be anchored.
- B. Pipe Anchors:
1. General: Provide anchors to fasten piping which is subject to expansion and contraction, and adjacent to equipment to prevent loading high forces onto the equipment.

C. Building Attachments:

1. Install within concrete or on structural steel or wood. Attachment to Wood Structure: Provide MSS Type 34 for attachment to wooden beam or approved attachment for a wood structure.
2. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints and at changes in direction of piping.
3. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

D. Bolting:

1. General: Provide bored, drilled or reamed holes for bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand sawn holes will not be accepted.

E. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor wall, and through equipment room walls and floors.

F. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:

1. Install fabricated pipe sleeve.
2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D. with specified material.
3. Seal each end airtight with a resilient nonhardening UL listed fire resistant ASTM 814 sealant.

G. Piping penetrations through Fire-rated (1 to 3 hour) Assemblies:

1. Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.
2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814. Use HOLDRITE HydroFlame or approved equivalent.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

3.5 FLASHING

- A. Flash and counterflash where piping passes through weather or waterproofed walls, floors and roofs.
- B. Flash vent soil pipes with flashings per Division 01, General Requirements.
- C. Flash floor drains over finished areas and roof drains, 10-inches clear on sides, minimum 36-inches x 36-inches sheet size. See Division 01, General Requirements. Fasten flashing to drain with clamping device.
- D. Install built up fixtures (mop sinks, shower stalls, shower floors) with water sealing systems/membranes to meet Code and as prescribed by Division 01, General Requirements and Section 22 00 00, Plumbing Basic Requirements. Meet all Code testing requirements. Provide drainage devices with appropriate flanges, clamps, etc. to meet these installation requirements and ensure a water-tight installation.

3.6 MISCELLANEOUS METAL AND MATERIALS

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts. Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.
- C. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete masonry or similar construction.
- D. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.
- E. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
 - 1. Set loose leveling and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
- F. Fabrication:
 - 1. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on Drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates and similar devices. Hot dip galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.
 - 2. Finishes:
 - a. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas with primer of same material before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
 - b. Metal in contact with Concrete, Masonry and Other Dissimilar Materials:
 - 1) Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
 - c. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

G. Metal Fabrication:

1. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
2. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
3. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of weld and methods used in correcting welding work, and with the following:
 - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.
4. Provide galvanized components for items exposed to weather.

END OF SECTION

SECTION 220548
VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Vibration Isolation
 - 2. Seismic - Bracing/Restraint Devices / Systems for Equipment and Piping

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.
 - 1. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 - 2. Section 22 30 00 - Plumbing Equipment

1.3 REFERENCES AND STANDARDS

- A. References and standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Vibration Isolation:
 - a. Product Data: Provide catalog data indicating size, type, load and deflection of each isolator; and percent of vibration transmitted based on lowest disturbing frequency of equipment.
 - b. Shop Drawings: Showing complete details of construction for steel and concrete bases including:
 - 1) Equipment mounting holes.
 - 2) Dimensions.
 - 3) Isolation selected for each support point.
 - 4) Details of mounting brackets for isolator.
 - 5) Weight distribution for each isolator.
 - 6) Details of seismic snubbers.
 - 7) Code number assigned to each isolator.
 - 2. Seismic Restraint:
 - a. Shop Drawings: Show compliance with requirements of Quality Assurance article of this Section. Shop Drawings will be stamped by professional structural engineer licensed in state of California.
 - b. Calculations: Submit seismic calculations indicating restraint loadings resulting from design seismic forces. Include anchorage details. Calculations will be certified by professional structural engineer licensed in the state of California.
 - c. Certifications: For restraining devices submit pre-approval certification number from government agency. Where pre-approval is not available, submit testing performed by independent laboratory or calculations sealed by professional structural engineer licensed in state of California certifying isolators and restraints will withstand seismic forces encountered.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
1. Vibration Isolation:
 - a. Except for packaged equipment with integral isolators, single manufacturer will select and furnish isolation required.
 - b. Deflections indicated will be minimum actual static deflections for specific equipment supported.
 - c. Isolator Stability:
 - 1) Size springs of sufficient diameter to maintain stability of equipment being supported with minimum horizontal to vertical stiffness ratio not less than 1:1. Spring diameters will be not less than 0.8 of the compressed height at rated load.
 - 2) Springs will have minimum additional travel to solid equal to 50 percent of the rated deflection.
 - 3) Springs will support 200 percent of rated load when fully compressed without deformation or failure.
 - d. Maximum Allowable Vibration Levels: Peak vibration velocities not to exceed 0.08 in/sec. correct equipment operating at vibration velocities that exceed this criteria.
 2. Seismic Restraint:
 - a. Seismic restraint and anchorage of permanent equipment and associated systems listed below to building structure will be designed to resist total design seismic force prescribed in local building code:
 - 1) Floor- or roof-mounted equipment weighing 400 pounds or greater.
 - 2) Suspended, wall-mounted or vibration isolated equipment weighing 20 pounds or greater.
 - 3) Housekeeping slabs: provide reinforcement and anchorage to building structure.
 - b. Where required, seismic sway bracing of suspended piping will meet the following:
 - 1) Pipe runs requiring seismic bracing will have a minimum of two traverse braces and one longitudinal brace. A longitudinal (or a traverse) brace at 90 degree change in direction may act as traverse (or longitudinal) brace if located within 2-feet of change in direction.
 - 2) Seismic bracing may not pass through seismic separation joint. Pipe runs that pass through seismic separation joints must be restrained within 5-feet of both sides of the separation.
 - 3) Seismic brace assembly spacing will not exceed 40-feet transverse and 80-feet longitudinal.
 - c. Seismic sway bracing of suspended piping will be performed for the following:
 - 1) Piping 8-inches nominal diameter and larger and trapeze systems where total area of pipe exceeds 28 square inches.
 - 2) Piping 4-inches nominal diameter and larger, all cast iron and PVC piping and trapeze systems with total aggregate weight of 10 pounds/foot or greater.
 - d. Seismic restraints may be omitted from suspended piping if the following conditions are satisfied:
 - 1) For piping supported by individual rod hangers 12-inches or less in length from top of pipe to bottom of structural support. Top connections to structure will have swivel joints, eye bolts, or vibration isolation hangers for the entire length of the system run.
 - 2) Lateral motion of the system will not cause damaging impact with surrounding systems or cause loss of system vertical support.
 - 3) System must be welded steel pipe, brazed copper pipe, or similar ductile material with ductile connections.
 - e. Seismic restraints, including anchors to building structure, will be designed by registered professional structural engineer licensed in state of California. Design will include:
 - 1) Number, size, capacity, and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both unit to curb and curb to structure.

- 2) Number, size, capacity, and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations approval number verifying the horizontal and vertical ratings of the seismic restraint devices.
- 3) Number, size, capacity, and location of braces and anchors for suspended piping and ductwork on as-built plan drawings.
- 4) Maximum seismic loads will be indicated on Drawings at each brace location. Drawings will bear stamp and signature of registered professional structural engineer who designed layout of braces.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Vibration Isolation:
 1. Amber-Booth.
 2. California Dynamics Corporation.
 3. Mason Industries, Inc.
 4. Kinetics Noise Control.
 5. Vibro-Acoustics.
 6. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
 7. Or approved equivalent.
- B. Seismic - Bracing / Restraint Devices / Systems for Equipment and Piping:
 1. Amber-Booth.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.
 4. Hilti, Inc.
 5. Mason Industries, Inc.
 6. Kinetics Noise Control.
 7. Unistrut.
 8. ISAT, Inc.
 9. Or approved equivalent.

2.2 VIBRATION ISOLATION

- A. Type 1 - Neoprene Pad: Rubber or neoprene waffle pads, single layer, 5/16-inch thick with pattern repeating on 1/2-inch centers; 40 to 50 durometer hardness; maximum loading 50 PSI, 1/4-inch thick steel load distribution plate. Mason Type SWM.
- B. Type 2 - Neoprene Mount: Double-deflection type, with steel or ductile-iron housing containing two separate and opposing, oil-resistant rubber or neoprene elements, factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Minimum static deflection of 0.20-inches. Mason Type BR.
- C. Type 3 - Spring: Freestanding, laterally stable, open-spring isolators, factory drilled for bolting to structure and bonded to 1/4-inch thick rubber isolator pad attached to baseplate underside, mounts with leveling bolts. Mason Type SLFH.
- D. Type 4 - Spring with Restraints: Laterally stable, open-spring isolators, factory drilled for bolting to structure and bonded to 1/4-inch thick rubber isolator pad attached to baseplate underside; mounts

with leveling bolts; steel or cast iron housing for directional seismic snubbing with resilient vertical-limit stops. Mason Type SLR or SSLFH.

- E. Type 5 - Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression; designed for 30-degree angular movement before hanger-rod misalignment without binding; seismic rebound washer; 1-inch minimum deflection. Mason Type PC30N.
- F. Seismic Snubbers: Directional interlocking steel members restrained by one-piece molded neoprene bushing, minimum of 3/4-inch thick with minimum 1/8-inch air gap in all directions, capable of withstanding 3 times the rated load capacity. Mason Type Z-1225.

2.3 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT AND PIPING

- A. General Requirements for Restraint Components: Rated strengths, features, and applications will be as defined in reports by agency acceptable to authorities having jurisdiction.
- B. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components will be at least four times the maximum seismic forces to which they will be subjected.
- C. Anchor bolts for attaching to concrete will be seismic-rated, drill-in, and stud-wedge or female-wedge type. Provide anchor bolts suitable for cracked concrete.
- D. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
- E. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Vibration isolators and seismic restraint systems must be installed in strict accordance with manufacturers written instructions and certified submittal data.
 - 2. Provide mounts for equipment installed outdoors for wind loads of 30 lbs. psf applied to any exposed surface of isolated equipment.
 - 3. Do not install equipment or pipe which makes rigid contact with building slabs, beams, studs, walls, etc.
 - 4. Anchor baseplate to floor or structure. Provide rubber grommets and washers to isolate bolt from base plate. Under no circumstances will isolation efficiency be destroyed when bolting the isolators to floor.
 - 5. Building Penetrations: Isolate water piping penetrating wall, ceilings, floors or shafts from the structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe at equipment room wall.
 - 6. Pipe Hangers in Equipment Rooms: Support water and gas piping connected to rotating equipment within equipment rooms on spring and neoprene hangers. The first three hangers from a piece of vibrating equipment are to have a minimum of 1/2 static deflection of equipment isolators. Other isolators should have a minimum of 1/4 static deflection of equipment isolators.

3.2 VIBRATION ISOLATION EQUIPMENT INSTALLATION

- A. Install isolation as indicated on Drawings by type and location and where indicated below.
- B. Isolation Mounts:
 - 1. Position vibration isolation hanger elements as high as possible in hanger rod assembly but not in contact with building structure. Install hangers so that hanger housing may rotate full 360 degrees about rod axis without contacting any object.

2. Where parallel running pipes are hung together on a trapeze which is isolated from the building, provide isolator deflections for largest determined by provisions for pipe isolation. Do not mix isolated and non-isolated pipes in the same trapeze.
 3. Install Type 3 and 4 isolators such that installed and operating heights of vibration isolated equipment is identical. Install limit stops so that they are out of contact during normal operation.
 4. Adjust leveling bolts and hanger rod bolts so isolated equipment is level and in proper alignment with connecting pipes.
- C. Isolating Pipe Hangers:
1. Install on compressed air and water piping connected to rotating equipment in the mechanical rooms. Provide isolating hanger supports for each piece of isolated equipment outside of mechanical rooms and where indicated.
 2. Isolated equipment items include base mounted pumps and line mounted pumps.
- D. Vibration isolators must not cause change of position of equipment or piping which would stress piping connections or misalign shafts or bearings.
- E. Vibration isolators and seismic restraint systems must be installed in strict accordance with manufacturers written instructions and certified submittal data.
- F. Anchor baseplate to floor or structure. Provide rubber grommets and washers to isolate bolt from base plate. Under no circumstances will isolation efficiency be destroyed when bolting the isolators to floor.
- G. Anchorage: Adequately anchor or brace plumbing equipment and piping to resist displacement due to seismic action, include snubbers on equipment mounted on spring isolators, pumps and the like.

3.3 SEISMIC RESTRAINTS

- A. General:
1. Install and adjust seismic restraints so that equipment and piping supports are not degraded by restraints.
 2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.
- B. Supported Equipment: Each vibration isolation frame for supported equipment will have a minimum of four seismic snubbers mounted as close as possible to vibration isolators and/or frame extremities.
- C. Bracing of Pipes: Branch lines may not be used to brace main lines.
- D. Suspended Equipment and Piping Cable Method:
1. Cables will be adjusted to the degree of slackness approved by Structural Engineer of Record.
 2. Uplift and downward restraint nuts and washers for Type 5 spring hangers will be adjusted so that there is a minimum 1/4-inch clearance.
- E. Vibration isolators and seismic restraint systems must be installed in strict accordance with manufacturers written instructions and certified submittal data.

END OF SECTION

**SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Plastic Nameplates
 - 2. Tags
 - 3. Plastic Pipe Markers

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Schedules:
 - a. Submit valve schedule for each piping system, in tabular format using Microsoft Word or Excel software. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.
 - b. Provide Schedules organized as follows:
 - 1) Equipment Type:
 - (a) Identification:
 - (b) Background:
 - (1) Size:
 - (2) Color:
 - (c) Lettering:
 - (1) Size:
 - (2) Color:
 - c. For renovations or expansions of existing systems, coordinate with Owner and develop valve schedule on existing schedule naming and format.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
 - 2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22, Plumbing Sections. Where more than a single type is specified for application, provide single selection for each product category.
- B. Plastic Nameplates:
 - 1. Brady Corporation
 - 2. Or approved equivalent.
- C. Tags:
 - 1. Brady Corporation
 - 2. Brimer
 - 3. Champion America Inc.
 - 4. Craftmark
 - 5. Seton Identification Products
 - 6. Or approved equivalent.
- D. Plastic Pipe Markers:
 - 1. Brady Corporation
 - 2. Brimer
 - 3. Champion America Inc.
 - 4. Craftmark
 - 5. Seton Identification Products
 - 6. Or approved equivalent.

2.2 PLASTIC NAMEPLATES

- A. Description: Engraving stock melamine plastic laminate in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide one-eighth-inch thick material.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2 inch (13 mm).
 - 3. Background Color: Black.
 - 4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
 - 5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.

2.3 TAGS

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

- C. Valve designations to be coordinated with existing valve identifications to ensure no repetitive designations are utilized.
- D. Chart/Schedules: Valve Schedule Frames. For each page of a valve schedule, provide glazed display frame with removable mounting as appropriate for wall construction upon which frame is to be mounted. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.
- E. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.
- F. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7-inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 - 4. Color: Yellow background with black lettering.

2.4 PLASTIC PIPE MARKERS

- A. Color: Conform to ASME A13.1 and ANSI Z535.1.
- B. Plastic Pipe Markers (for external diameters of 6-inches and larger including insulation): Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers (for external diameters less than 6-inches including insulation): Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Minimum information indicating flow direction arrow and identification of fluid being conveyed.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Lettering and Graphics:
 - 1. General: Coordinate names, abbreviations and other designations used in plumbing identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
 - 2. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).
- B. Preparation:
 - 1. Degrease and clean surfaces to receive adhesive for identification materials.
 - 2. Prepare surfaces for stencil painting.
- C. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- D. Install valve schedule at each mechanical room.
- E. Lettering and Graphics:
 - 1. If not otherwise indicated, as recommended by Manufacturers above. See Lettering and Graphics Article below.

3.2 PLASTIC NAMEPLATES

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners.
- B. Access Doors: Provide markers or stenciled signs on each access door and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.

3.3 TAGS

- A. Coordinate with the facility maintenance personnel to insure consistency with the existing tagging system.
- B. Tag balancing valves with balanced GPM or CFM indicated after balancing is completed and accepted.
- C. Install tags with corrosion resistant chain.
- D. Identify pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body. Small devices, such as in-line pumps, may be identified with tags.
- E. Identify control panels and major control components outside panels with plastic nameplates riveted to equipment body.
- F. Identify valves in main and branch piping with metal tags. Indicate valve function and the normally open or closed positions on the valve tag.

3.4 PLASTIC PIPE MARKERS

- A. Install plastic pipe markers in accordance with manufacturer's instructions.
- B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- C. For exterior underground piping installations, Install underground plastic pipe markers with tracer wire 6 to 8-inches below finished grade directly above buried pipe.
- D. Identify piping, concealed or exposed, with plastic tape pipe markers. Use metal tags on piping 3/4-inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20-feet (reduced to 10-feet in congested areas and mechanical equipment rooms) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction. Locate near branches, valves, control devices, equipment connections, access doors, floor/wall penetrations.
- E. Access Doors: Provide markers or stenciled signs on each access door and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.

END OF SECTION

SECTION 220593
TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
1. Balancing water flow within distribution systems of all Division 22, Plumbing Sections, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
 2. Adjusting Plumbing systems to provide indicated quantities.
 3. Verifying that automatic control devices are functioning properly.
 4. Reporting results of the activities and procedures specified in this Section.

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
1. Acceptable Balance Firm:
 - a. General:
 - 1) Procure services of independent balance and testing agency which specializes in balancing and testing of plumbing systems, to balance, adjust and test water circulating. Minimum Experience: 5 years.
 - b. Industry Standards: Testing and Balancing will conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
 - 1) NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
 - 2) ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
 - c. Test Observation: If requested, conduct tests in the presence of the Architect or the Architect's representative.
 2. Provide proof of testing agency having successfully completed at least five projects of similar size and scope.
 3. Code Compliance: Perform tests in the presence of the Authority Having Jurisdiction (AHJ) where required by the Authority Having Jurisdiction (AHJ).
 4. Owner Witness: Perform tests in the presence of the Owners representative.
 5. Engineer Witness: The engineer or engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.

6. Simultaneous Testing: Test observations by the Authority Having Jurisdiction (AHJ), the Owner's representative and the engineer's representative need not occur simultaneously.
7. Do not perform testing, adjusting, and balancing work until plumbing equipment has been completely installed and is operating continuously as required.
8. Conduct testing and balancing with clean filters in place. Clean strainers prior to performing testing and balancing.
9. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by AABC or NEBB.
10. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location.
 - a. Agenda Items: Include at least the following:
 - 1) Submittal distribution requirements.
 - 2) Testing, adjusting, and balancing plan.
 - 3) Work schedule and Project site access requirements.
 - 4) Coordination and cooperation of trades and subcontractors.
 - 5) Coordination of documentation and communication flow.
11. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 - a. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
 - b. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
12. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."
13. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
14. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.
15. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
16. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.7 DEFINITIONS

- A. Adjust: To regulate fluid flow rate at the equipment.
- B. Balance: To proportion flows within the distribution system, including sub mains, branches, and terminals, according to design quantities.
- C. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- D. Report Forms: Test data sheets for recording test data in logical order.
- E. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

- F. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- G. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- H. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- I. TAB: Testing and Balancing.
- J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- K. Test: A procedure to determine quantitative performance of a system or equipment.
- L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- M. AABC: Associated Air Balance Council.
- N. AMCA: Air Movement and Control Association.
- O. CTI: Cooling Tower Institute.
- P. NEBB: National Environmental Balancing Bureau.
- Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.8 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, controls installers, and other mechanics to operate systems and equipment to support and assist testing, adjusting, and balancing activities.
- B. Notice: Provide 7 days advance notice for each test. Include scheduled test dates and times.
- C. Perform testing, adjusting, and balancing after leakage and pressure tests on piping distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

- A. Non-Owner Occupancy: Complete balancing of building systems prior to Substantial Completion and owner occupancy.

3.2 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and existing building record documents (if available) to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 2. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

- B. Examine approved submittal data of Plumbing systems and equipment.
- C. Examine equipment performance data including pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- E. Examine system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- G. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.
- H. Examine equipment for installation and for properly operating safety interlocks and controls.
- I. Examine automatic temperature system components to verify the following:
 - 1. Valves, and other controlled devices operate by the intended controller.
 - 2. Valves are in the position indicated by the controller.
 - 3. Integrity of valves for free and full operation and for tightness of fully closed and fully open positions.
 - 4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
 - 5. Sensors are located to sense only the intended conditions.
 - 6. Sequence of operation for control modes is according to the Contract Documents.
 - 7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
- J. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.
- K. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Isolating and balancing valves are open and control valves are operational.
- C. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - 1. Attendance is required by installers whose work will be tested, adjusted, or balanced.
- D. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

3.4 GENERAL TESTING AND BALANCING PROCEDURES

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut insulation for pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment settings with paint or other suitable, permanent identification material, including control positions, valve indicators and similar controls and devices, to show final settings.

3.5 ADJUSTMENT TOLERANCES

- A. Piping Systems: Adjust to within plus or minus 10 percent of design.

3.6 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on drawings locations where other critical measurements were taken and cross reference location in final report.

3.7 FUNDAMENTAL PROCEDURES FOR PIPING SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 10 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open manual valves for maximum flow.
 - 2. Check expansion tank liquid level, or air charge if bladder type.
 - 3. Check makeup-water-station pressure gauge for adequate pressure.
 - 4. Check flow-control valves for specified sequence of operation and set at design flow.
 - 5. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.8 FINAL REPORT

- A. General: Computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into Sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of the instruments used for procedures, along with proof of calibration.

- C. Final Report Contents: In addition to the certified field report data, include the following:
1. Pump curves.
 2. Field test reports prepared by system and equipment installers.
 3. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
- D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
1. Title page.
 2. Name and address of testing, adjusting, and balancing Agent.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of testing, adjusting, and balancing Agent who certifies the report.
 10. Summary of contents, including the following:
 - a. Design versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 11. Nomenclature sheets for each item of equipment.
 12. Notes to explain why certain final data in the body of reports vary from design values.
- E. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.
1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm (L/s).
 - g. Water pressure differential in feet of head or PSIG (kPa).
 - h. Required net positive suction head in feet of head or PSIG (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.

END OF SECTION

SECTION 220700 PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Type 1, Fiberglass Pipe Insulation
 - 2. Type 2, Flexible Elastomeric Insulation
 - 3. Type 7, ADA Accessible Lavatory/Sink Insulation Kit
 - 4. Accessories
 - 5. Pipe Fitting Insulation Covers

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Piping insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Installer qualifications.
 - 2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
 - 3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
 - 4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
 - 5. Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.7 FIRE HAZARD CLASSIFICATION

- A. Maximum fire hazard classification of composite insulation construction as installed to be not more than a flame spread of 25, fuel contribution of 50 and smoke development of 50 as tested by ASTM E84 (NFPA 255) method.
- B. Test pipe insulation in accordance with requirements of UL "Pipe and Equipment Coverings".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General:
 - 1. Armacell LLC Armaflex
 - 2. Certaineed
 - 3. Johns Manville
 - 4. Knauf
 - 5. Owens-Corning
 - 6. PPG
 - 7. Or approved equivalent.
- B. Type 1, Fiberglass Pipe Insulation:
 - 1. Owens-Corning
 - 2. Johns Manville
 - 3. Or approved equivalent.
- C. Type 2, Flexible Elastomeric Insulation:
 - 1. Glue:
 - a. Armacell LLC Armaflex Low VOC Adhesive
 - b. Halstead
 - c. Or approved equivalent.
 - 2. Paint:
 - a. Armacell LLC Armaflex
 - b. Halstead
 - c. Or approved equivalent.
- D. Type 7, ADA Accessible Lavatory/Sink Insulation Kit:
 - 1. IPS/Truebro
 - 2. McGuire/Pro-Wrap
 - 3. Plumberex/Pro-Extreme
 - 4. Brocar Trap Wrap
 - 5. Or approved equivalent.
- E. Accessories:
 - 1. ITW Insulation Systems
 - 2. Or approved equivalent.
- F. Pipe Fitting Insulation Covers:
 - 1. Zeston Johns Manville
 - 2. ITW Insulation Systems
 - 3. Or approved equivalent.

2.2 TYPE 1, FIBERGLASS PIPE INSULATION

- A. Glass Fiber: ASTM C547; rigid molded, noncombustible.

1. Thermal Conductivity Value: 0.27 BTU*in/(hr*sf°F) at 75 degrees F.
2. Maximum Service Temperature: 850 degrees F.
3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, with self sealing longitudinal laps and butt strips or vapor barrier mastic.

2.3 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

- A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.
1. Thermal Conductivity Value: 0.25 BTU*in/(hr*sf°F) at 75 degrees F.
 2. Maximum Service Temperature of 220 degrees F.
 3. Maximum Flame Spread: 25.
 4. Maximum Smoke Developed: 50 (3/4-inch thick and below).
 5. Connection: Waterproof vapor retarder adhesive as needed.
 6. UV Protection: UV outdoor protective coating per manufacturers requirements.
- B. Glue: Contact adhesive specifically manufactured for cementing flexible elastomeric foam.
- C. Paint: Nonhardening high elasticity type, specifically manufactured as a protective covering of flexible elastomeric foam insulation for prevention of degradation due to exposure to sunlight and weather.

2.4 TYPE 7, ADA ACCESSIBLE LAVATORY/SINK INSULATION KIT

- A. P-traps, trap arms, tail pieces, hot water and cold water insulating guards. Molded closed cell insulation with vinyl cover and nylon fasteners, paintable. Thermal conductivity; $K = 1.17$ (BTU*in/(hr*sf°F) at 75 degrees F mean temperature. Provide accessories as required for complete installation covering all exposed waste piping, water piping, stops and supplies. Color white.

2.5 ACCESSORIES

- A. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
- B. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have same flame and smoke component ratings as insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide non-water soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

2.6 PIPE FITTING INSULATION COVERS

- A. PVC Plastic Fitting Covers: Schuller Zeston 2000, Knauf Proto Fitting or approved equivalent. One-piece molded type fitting covers and jacketing material, gloss white. Connections: Tacks; pressure sensitive color matching vinyl tape.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION INFORMATION

- A. Verification of Conditions:
1. Do not apply insulation until pressure testing of piping has been completed. Do not apply insulation over heat tracing until system tested. Do not apply insulation until piping has been inspected.
 2. Examine areas and conditions under which insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

- B. Preparation:
1. Clean and dry surfaces to be insulated.
- C. Installation:
1. Insulation: Continuous through walls, floors and partitions except where noted otherwise.
 2. Piping and Equipment:
 - a. Install insulation over clean, dry surfaces with adjoining Sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
 - b. Cover insulation on pipes above ground, outside of building, with aluminum jacketing. Position seam on bottom of pipe.
- D. Provide accessories as required. See Part 2 Article "Accessories" above.
- E. Protection and Replacement:
1. Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- F. Labeling and Marking:
1. Provide labels, arrows and color coding on piping. Attach labels and flow direction arrows to jacketing per Section 22 05 53, Identification for Plumbing Piping and Equipment.
- G. Piping Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Pipe Size	Insulation Thickness
Hot Water Piping Above Grade	1	Runouts up to 2-inch	1-inch
		Mains =<2-inch	1-inch
		Mains >2-inch	1-1/2-inch
Hot Water Circulation Piping Above Grade	1	Runouts, up to 2-inch	1-inch
		Mains =<2-inch	1-inch
		Mains >2-inch	1-1/2-inch
Domestic Water Piping Exposed to Weather	1, 2	All	1-1/2-inch
Piping with Heat Tracing	1, 2	=<2-inch	1-inch
		> 2-inch	1-1/2-inch
ADA Accessible Lavatory/Sink	7	All	As Listed
Condensate Drain Piping	1, 2	All	1/2-inch

3.2 TYPE 1, FIBERGLASS PIPE INSULATION

- A. See General Installation Requirements above.
- B. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

- C. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.
- D. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation Section at insulation shields for lines 2-inches and larger (hot and cold piping).
- E. Install in accordance with manufacturer's instructions for below grade installation.

3.3 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

- A. See General Installation Requirements above.
- B. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and undergrade with two coats of finish as recommended by manufacturer.
- C. Flexible Elastomeric Tubing: Slip insulation over piping or if piping is already installed, it should be slit and snapped over piping. Joints and butt ends must be adhered with 520 adhesive.
- D. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation Section at insulation shields for lines 2-inches and larger (hot and cold piping).
- E. Install in accordance with manufacturer's instructions for below grade installation.

3.4 TYPE 7, ADA ACCESSIBLE LAVATORY/SINK INSULATION KIT

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturers instructions.
- C. Provide lavatory/sink insulation kit. Install on waste fittings, hot and cold water stops and supplies.

3.5 ACCESSORIES

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturers instructions.
- C. Provide and install accessories for all insulation types listed in this Section.

3.6 PIPE FITTING INSULATION COVERS

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturers instructions.

END OF SECTION



SECTION 221000 PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. General
 - 2. Sanitary, Drainage (Rain/Stormwater) DWV Piping, Buried Within 5-feet of Building
 - 3. Sanitary, Drainage (Rain/Stormwater) DWV Piping, Above Grade
 - 4. Water Piping, Buried Within 5-feet of Building
 - 5. Hot and Cold Domestic Water Above Grade
 - 6. Condensate Piping
 - 7. Primer Piping
 - 8. Cleanouts

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. NSF 61, Annex G
 - 2. Steel pipe to conform to ASTM and ANSI Standards as specified in this Section.
 - 3. Copper piping to conform to ASTM B88, B306 and B208 and the standards of Copper Development Association (CDA), and American Welding Society, (AWS).
 - 4. Cast Iron Piping to conform to standards of ASTM A-74, CISPI 301 and FM 1680.
 - 5. Manufacturer's Standards Society (MSS) for valving and support reference standard.
 - 6. American Waters Association (AWWA) for Valving Assembly Standards.
 - 7. American Society of Sanitation Engineers (ASSE) for Valving Standards.
 - 8. American National Standards Institute (ANSI) for Piping Standards.
 - 9. NFPA Standard 51B - "Fire Prevention in Use of Cutting and Welding Processes".

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. See component manufacturers listed in individual articles below.
- B. Cerro
- C. Dodge Phelps
- D. Tyler
- E. ADS
- F. Charlotte
- G. Elkhart
- H. Enfield
- I. Spears
- J. Nibco
- K. Orion
- L. American-USA
- M. or approved equivalent.
- N. Cleanouts:
 - 1. J.R. Smith
 - 2. Zurn
 - 3. Wade
 - 4. Watts
 - 5. Or approved equivalent.
- O. Firestopping Penetrations in Fire Rated Wall Floor Assemblies:
 - 1. Hilti
 - 2. Proset
 - 3. Or approved equivalent.

2.2 GENERAL

- A. Provide pipe, tube and fittings of the same type, fitting requirements, grade, class and the size and weight indicated or required for each service, as indicated in other Division 22, Plumbing Specifications. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.
- B. Manufactured materials delivered, new to the project site and stored in their original containers.
- C. Product Marking: Each item to be furnished with legible markings indicating: name brand and manufacturer, manufacturing process, heat number and markings as required per ASTM and UL/FM Standards.

2.3 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, BURIED WITHIN 5-FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A888/CISPI 301 hubless.
 - 1. Fittings: Cast iron.
 - 2. Coupling Assembly:
 - a. Heavy Duty: ASTM C1540/HUSKYSD4000, Clamp-All Hi-Torq 125 coupling. Husky SD 4000.

2.4 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A888/CISPI 301 hubless.
 - 1. Fittings: Cast iron.
 - 2. Coupling Assembly:
 - a. Standard Duty: ASTM C1277 or CISPI 310.
- B. Copper Tube: ASTM B 306, DWV
 - 1. Fittings: ASME B16.29, wrought copper.
 - 2. Joints: ASTM B32, alloy Sn50 solder.

2.5 WATER PIPING, BURIED WITHIN 5-FEET OF BUILDING

- A. Copper Pipe: ASTM B88, hard drawn, Type K (A).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
 - 2. Joints: Brazed - BCuP2.

2.6 HOT AND COLD DOMESTIC WATER ABOVE GRADE

- A. Copper Tube: 3-inches and above. ASTM B88 (ASTM BA88m), Type L (B), Drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: Brazed BCuP2.
- B. Copper Tube: 2-1/2-inches and smaller. ASTM B88 (ASTM B88M), Type L (B), Drawn.
 - 1. Fittings: ASME B16.18 copper.
 - 2. Joints: ASTM B32, alloy Sn95 solder.

2.7 CONDENSATE PIPING

- A. Copper Tube: ASTM B 88 (ASTM B898M), Type M (C)
 - 1. Fittings: ASME B16.29, wrought copper.
 - 2. Joints: ASTM B32, alloy Sn50 solder.
- B. Piping for drainage of condensate from combustion fuel sources (such as condensing boilers and water heaters) is to be chemical resistant piping as noted in this Section for area of application.
- C. CPVC (Chlorinated Poly Vinyl Chloride) Pipe and Fittings:
 - 1. Pipe and Fittings: Schedule 40, NSF-14, ASTM 439, IAPMO IS20-96, socket fittings, solvent weld.

2.8 PRIMER PIPING

- A. Above Ground: Type L hard-drawn copper tubing with wrought sweat fittings and soldered joints.
- B. Belowground: Type L soft annealed copper tubing with wrought sweat fittings and brazed joints.

2.9 CLEANOUTS

- A. General: Locate cleanouts as shown on Drawings and as required by local code. Cleanouts same size as pipe except that greater than 4-inches will not be required. Plastic components not allowed, except unless specifically noted.
- B. Types:
1. Tile Floor Cleanouts: J. R. Smith 4020 with round heavy-duty nickel bronze top, taper thread, ABS plug and vandalproof screws.
 2. Carpeted Floor Cleanout: J. R. Smith 4020-X with carpet clamping frame 4023-Y, round heavy-duty nickel bronze top, taper thread, ABS plug, carpet clamping device and vandalproof screws.
 3. Concrete Floor Cleanout (General): J. R. Smith 4020 with round heavy-duty nickel bronze top, taper thread and ABS plug with standard screws or vandalproof screws.
 4. Parking, Drives and Concrete Floor Cleanouts (Heavy Load): J. R. Smith 4100 with round heavy-duty nickel bronze top, taper thread and ABS plug with vandalproof screws.
 5. Wall Cleanout: J. R. Smith 4472-U, countersunk bronze taper thread plug, stainless steel shallow cover and vandalproof screws.
 6. Outside Area Walks: J. R. Smith 4020-U with round heavy-duty nickel bronze top, taper thread, ABS plug and top secured with vandalproof screws. Install in 18- by 18- by 6-inch deep concrete pad flush with grade.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Underground Piping Systems Examination:
1. Verify that excavations are to required grade, dry, and not over-excavated.
- B. General:
1. Perform necessary excavation and backfill required for installation of plumbing work. Repair piping or other work at no expense to Owner.
 2. Water: Keep excavations free of standing water. Reexcavate and fill back excavations damaged or softened by water or frost to original level with sand, crushed rock or other approved material at no expense to Owner.
 3. Tests: During progress of work for compacted fill, Owner reserves right to request compaction tests made under direction of testing laboratory.
 4. Trench Excavation: Excavate trenches to necessary depth and width, removing rocks, unstable soil (muck, peat), roots and stumps. Excavation material is classified as "base fill" and "native." Base fill excavation material consisting of placed crushed rock may be used as backfill above "Pipe Zone." Remove and dispose off site native excavation material. Adequate width of trench for proper installation of piping or conduit.
 5. Support Foundations:
 - a. Foundations: Excavate trenches located in unstable ground areas below elevation required for installation of piping to depth which is determined by Architect as appropriate for conditions encountered. Place and compact approved foundation material in excavation up to "Bedding Zone." Dewatering, placement, compaction and disposal of excavated materials to conform to requirements contained in other Sections of Specifications or Drawings.
 - b. Over-Excavations: Where trench excavation exceeds required depths, provide, place and compact suitable bedding material to proper grade or elevation at no additional cost to Owner.
 - c. Foundation Material: Where native material has been removed, place and compact necessary foundation material to form base for replacement of required thickness of bedding material.

	Class A		Class B	
Material Passing	Min.	Max.	Min.	Max.
3/4-inch Square Opening	27	47	0	1

- d. Bedding Material: Full bed piping on sand, pea gravel, or 3/4-inch minus crushed rock. Place minimum 4-inch deep layer of sand, pea gravel, or crushed rock on leveled trench bottom for this purpose. Remove bedding to necessary depth for piping bells and couplings to maintain contact of pipe on bedding for its entire length. Provide additional bedding in excessively wet, unstable, or solid rock trench bottom conditions as required to provide firm foundation.
6. Backfilling:
- a. Following installation and successful completion of required tests, backfill piping in lifts.
- 1) In "Pipe Zone" place backfill material and compact in lifts not to exceed 6-inches in depth to height of 12-inches above top of pipe. Place backfill material to obtain contact with entire periphery of pipe, without disturbing or displacing pipe.
 - 2) Place and compact backfill above "Pipe Zone" in layers not to exceed 12-inches in depth.
- b. Backfill Material:
- 1) Backfill Material in "Pipe Zone": 3/4-inch minus crushed rock, sand or pea gravel.
 - 2) Crushed rock, fill sand or other backfill material approved elsewhere in Specifications may be used above "Pipe Zone."
7. Compaction of Trench Backfill:
- a. Where compaction of trench backfill material is required, use one of following methods or combination thereof:
- 1) Mechanical tamper,
 - 2) Vibratory compactor, or
 - 3) Other approved methods appropriate to conditions encountered.
- b. Architect to have right to change methods and limits to better accommodate field conditions. Compaction sufficient to attain 95 percent of maximum density at optimum moisture content unless noted otherwise on Drawings or elsewhere in Specifications. Water "puddling" or "washing" is prohibited.
- C. General Installation:
1. Work performed by experienced journeyman plumbers. No exceptions.
 2. Provide access panels for concealed valves, shock arrestors, trap primers and the like.
 3. Install pipes and pipe fittings in accordance with recognized industry practices and manufacturers recommendations.
 4. Align piping accurately at connections, within 3/32-inch misalignment tolerance. Comply with ANSI B31 Code for Pressure Piping.
 5. Locate piping runs, as indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2-inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1-inch clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view by locating it in column enclosures, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.
 - a. Do not run piping through transformer vaults, telephone, elevator, electrical or electronic equipment spaces or enclosures unless indicated on Drawings.

- b. Concealed Piping Above Suspended Ceiling: Plan and coordinate to avoid interferences; install to maintain suspended ceiling heights shown on Architectural Drawings. Allow sufficient space above removable ceiling panels for panel removal. Locate piping so that valves are visible and accessible within 24-inches horizontally and vertically from point of access to the ceiling space. Provide plenum rated materials for ceiling spaces which are being used as plenums.
- c. Exposed Work: Run pipes parallel to the closest wall unless otherwise shown on Drawings; maintain maximum headroom; avoid light fixtures.
- d. Insulation Space Allowance: In piping work, allow space for pipe insulation and jackets. If interferences occur, move the piping to accommodate insulation thickness specified.
- e. Pipe Lengths: Do not use short lengths or nipples at locations where a full length of pipe will fit.
- f. Alignment Prior to Supporting and Anchoring: Place piping in proper alignment and position prior to connection to anchors, expansion loops, and equipment. Furnish jacking devices, temporary steel structural members, and assembled structures as necessary. Remove temporary equipment and structures supplied by contractor at completion; such items to remain Contractor property.
- g. Valve and Equipment Connections: Piping not to place undue stress on flanged valves and equipment connections. Mating flange faces to be true and parallel to each other and not to require springing of piping for assembly. Pipe hangers and supports to carry the full weight of the pipe and fluid.
- h. Piping Leaks: Correct immediately; use new materials; leak-sealing compounds or peening not permitted.
- i. Pressure Ratings of Fittings, Valves, and Devices in Piping Systems: Pressure rating to be equal to or greater than the maximum working pressure of the system.
- j. Equipment Vents and Drains: Provide for coils and vessels which contain water. Provide isolation valves and outlet valves at piping high and low points to permit venting and draining of the vessel without venting and draining connected piping. Provide hose connections and caps on drain lines.
- k. Escutcheon Plates: Where exposed insulated and uninsulated piping passes through walls, floors or ceilings; provide spring clip type. Provide plates on both sides of wall or floor.

D. Testing:

1. General:

- a. Provide temporary equipment for testing, including pumps, compressors, tanks, and gauges, as required. Test piping systems before insulation (if any) is installed and remove or disengage control devices before testing. Where necessary, test Sections of each piping system independently, but do not use piping valves to isolate Sections where test pressures exceed local valve operating pressure rating. Fill each Section with water, compressed air, or nitrogen and pressurize for the indicated pressure and time.
- b. Notify Architect and local Plumbing Inspector 2 days before tests.
- c. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in Sections if minimum head cannot be maintained in each Section. 5 PSI head to be minimum pressure at highest joint.
- d. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.
- e. Send test results to Architect for review and approval and include in Operation and Maintenance Manual.

2. Testing of Pressurized Systems:

- a. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
- b. Observe each test Section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.

3. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at hydrostatic pressure of 125 PSIG.
- E. Corrosive Soil Conditions:
1. Wrap steel, iron, copper or other metal piping materials/fittings with Protecto Wrap 200, 30 mils or greater. Maintain a 1/2-inch overlap and install per manufacturer's recommendations.
 2. Provide epoxy coated cast iron pipe and fittings for drainage systems.
 3. Obtain and review project soils report for verification of requirements concerning corrosive soils.
- F. Protection:
1. Keep pipe openings closed by means of plugs or caps to prevent entrance of foreign matter. Protect piping, ductwork, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore to its original condition or replace fixtures, equipment or apparatus damaged prior to final acceptance of work.
- G. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:
1. Reference Division 7.
 2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.
- H. Piping to be cut squarely, free of rough edges and reamed to full bore. Piping to be fully inserted into fittings.
- I. Provide joints of type indicated in each piping system.
- J. Thread pipe in accordance with ANSI/ASME B1.20.1 Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- K. Sleeves:
1. Pipe Sleeves:
 - a. Layout work in advance of pouring concrete, furnish, and set sleeves necessary to complete work.
 - b. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor. Caulk pipes passing through floor with non-shrinking grout or approved caulking compound (Except DWV Piping penetrating a concrete Slab set on Finish Grade), provide "Link-Seal" sleeve sealing system for concrete/slab penetrations which are below grade. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements
 - c. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with non-shrinking caulking compound. Provide modular link sealing system for concrete penetrations which are below grade. Caulk/seal piping passing through fire-rated assemblies per local AHJ requirements.
 - d. Beam Sleeves: Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Indicate penetrations on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Plumbing Drawings are diagrammatic. Offset piping as required to meet these limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.

2. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
 - a. Install fabricated pipe sleeve.
 - b. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D.
 - c. Seal each end airtight with a resilient nonhardening seal per code.
3. Piping penetrations through fire-rated (1 to 3 hour) assemblies:
 - a. Select and install pre-engineered pipe penetration system in accordance with UL listing and manufacturer's recommendation.
 - b. Reference Division 7.
 - c. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E84.

3.2 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, BURIED WITHIN 5-FEET OF BUILDING

- A. Excavation and Backfill:
 1. See 3.01B. above.
- B. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in Sections if minimum head cannot be maintained in each Section. 5 PSI head to be minimum pressure at highest joint.
- C. Corrosive Soil Conditions:
 1. Wrap steel, iron, copper or other metal piping materials/fittings with Protecto Wrap 200, 30 mils or greater. Maintain a 1/2-inch overlap and install per manufacturer's requirements.
 2. Provide epoxy coated cast iron pipe and fittings for drainage systems.
- D. Cast-Iron Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.
- E. Sanitary and Storm Drainage:
 1. Piping to be graded at a uniform pitch of 2 percent unless otherwise noted on Drawings.
 2. Indirect Waste or Drain Piping: Extend piping to discharge as shown on Drawings. Maintain minimum air gap. Provide traps on direct waste or drain piping exceeding 60-inches.
 3. Fixture Carriers: Concealed fixture carriers for wall hung plumbing fixtures are specified in Section 22 40 00.
 4. Drains:
 - a. Install drains to suit finished floor or roof surface. Install drains and components per manufacturer's instructions. Arrange for flooring to be sloped to floor drain or sink a minimum of 1/2-inch below finished floor elevation.
 - b. Install P-traps for hub drains, floor drains and floor sinks. P-traps to be of the same materials as soil and waste piping. Provide trap primer assembly for each drain or floor sink.
 5. Wall Access Panel: Secure to wall framing and install so that flange forms a close fitting joint with the finished wall surface.
 6. Heat trace and insulate P-traps exposed to freezing conditions. Provide heat trace and electronic components to Division 26 for installation.
 7. Insulate horizontal branch lines from floor sinks, receptors and drains receiving cold discharge from equipment and appliances.

- F. Epoxy Coated Cast Iron Pipe and Fittings: Coating of cut piping: The piping terminus of any cut piping shall be coated with an applied epoxy per manufactures instructions. Macroopxy 686 by Sherwin Williams, Scotch Cote 323.

3.3 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, ABOVE GRADE

- A. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in Sections if minimum head cannot be maintained in each Section. 5 PSI head to be minimum pressure at highest joint.
- B. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:
 - 1. Reference Division 7.
 - 2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.
- C. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM std. B-32, in accordance with IAPMO Is 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints to be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes to be water soluble for copper and brass potable water applications, and meets CDA standard test method 1.0 and ASTM B813-91. Solder to be applied until a full fillet is present around the joint. Solder and flux not to be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosion flux not to be present at the jobsite.
- D. Cast-Iron Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.
- E. Sanitary and Storm Drainage:
 - 1. Piping to be graded at a uniform pitch of 2 percent unless otherwise noted on Drawings.
 - 2. Indirect Waste or Drain Piping: Extend piping to discharge as shown on Drawings. Maintain minimum air gap. Provide traps on direct waste or drain piping exceeding 60-inches.
 - 3. Fixture Carriers: Concealed fixture carriers for wall hung plumbing fixtures are specified in Section 22 40 00.
 - 4. Drains:
 - a. Install drains to suit finished floor or roof surface. Install drains and components per manufacturer's instructions. Arrange for flooring to be sloped to floor drain or sink a minimum of 1/2-inch below finished floor elevation.
 - b. Install P-traps for hub drains, floor drains and floor sinks. P-traps to be of the same materials as soil and waste piping. Provide trap primer assembly for each drain or floor sink.
 - 5. Wall Access Panel: Secure to wall framing and install so that flange forms a close fitting joint with the finished wall surface.
 - 6. Heat trace and insulate P-traps exposed to freezing conditions. Provide heat trace and electronic components to Division 26 for installation.
 - 7. Insulate horizontal branch lines from floor sinks, receptors and drains receiving cold discharge from equipment and appliances.

3.4 WATER PIPING, BURIED WITHIN 5-FEET OF BUILDING

- A. Excavation and Backfill:
 - 1. See 3.01 B. above.

- B. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.
- C. Domestic Water:
1. "Piping" to include pipes, fittings, nipples, valves and accessories connected thereto.
 2. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts, flues, conduits and work of other trades, and as close to ceiling or other construction as practical, free of unnecessary traps or bends.
 3. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.
 4. Piping connections to equipment to be made up with unions.
 5. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.
 6. Use reducers or increasers. Use no bushings.
 7. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageways.
 8. Cover, cap or otherwise protect open ends of piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect and sterilize water supply piping as specified. Furnish written report on final water quality results.
 9. Exposed connections to equipment to be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bent piping to be permitted.
 10. Ferrous to non-ferrous connections to be made by means of dielectric fittings.
 11. Use extra heavy pipe for nipples, where unthreaded portion is less than 1-1/2-inches. Use no close nipples. Use only shoulder-type nipples.
 12. Through-Wall Pipes: Type 'L' copper tubing for through-wall pipes which connect to exposed stops at wall surface. Anchor the pipes in the wall; attach pipe with U-bolts to steel back-up plates or steel angles anchored in the wall. Provide wrought copper elbow which securely anchors ears in wall at through-wall pipes.
 13. Provide drain valves at base of risers and at low points on the system.
 14. Backflow Preventers: Pipe relief to nearest drain. Slope at 2 percent.
- D. Sterilization of Domestic Water System:
1. General: Upon completion of tests and necessary replacements, thoroughly flush and disinfect domestic water piping.
 2. Method: After thoroughly flushing system with water to remove sediment, fill system with a solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 3 hours. After retention, drain, reflush and return system to service.
 3. Certification: Provide copy of domestic water chlorination certificate in each operations and maintenance manual.
 - ~~△ 4. Provide water line disinfections performed by a licensed contractor with training in potable water line disinfections~~
 - △ 4. Provide water line disinfections performed by a D1 Water Operator licensed in the State of California.

3.5 HOT AND COLD DOMESTIC WATER ABOVE GRADE

- A. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.
- B. Testing of Pressurized Systems:
1. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.

2. Observe each test Section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.
- C. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at hydrostatic pressure of 125 PSIG.
- D. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:
1. Reference Division 7.
 2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.
- E. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM std. B-32, in accordance with IAPMO Is 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints to be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes to be water soluble for copper and brass potable water applications, and meets CDA standard test method 1.0 and ASTM B813-91. Solder to be applied until a full fillet is present around the joint. Solder and flux not to be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosion flux not to be present at the jobsite.
- F. Braze copper tube and fitting socket with BCUP series filler metal without flux. Listed brazing flux to be used for joining of copper tube to brass or bronze fittings and will meet AWS FB3A or FB3C. "Shock" cooling is prohibited. a continuous fillet is to be visible around the completed joint. After cooling, flux residue to be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10 percent nickel. Piping is to be capped or plugged during construction to prevent entry of foreign material.
- G. Domestic Water:
1. "Piping" to include pipes, fittings, nipples, valves and accessories connected thereto.
 2. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts, flues, conduits and work of other trades, and as close to ceiling or other construction as practical, free of unnecessary traps or bends.
 3. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.
 4. Piping connections to equipment to be made up with unions.
 5. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.
 6. Use reducers or increasers. Use no bushings.
 7. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageways.
 8. Cover, cap or otherwise protect open ends of piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect and sterilize water supply piping as specified. Furnish written report on final water quality results.
 9. Exposed connections to equipment to be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bent piping to be permitted.
 10. Ferrous to non-ferrous connections to be made by means of dielectric fittings.
 11. Use extra heavy pipe for nipples, where unthreaded portion is less than 1-1/2-inches. Use no close nipples. Use only shoulder-type nipples.
 12. Through-Wall Pipes: Type 'L' copper tubing for through-wall pipes which connect to exposed stops at wall surface. Anchor the pipes in the wall; attach pipe with U-bolts to steel back-up plates or steel angles anchored in the wall. Provide wrought copper elbow which securely anchors ears in wall at through-wall pipes.
 13. Provide drain valves at base of risers and at low points on the system.
 14. Backflow Preventers: Pipe relief to nearest drain. Slope at 2 percent.

H. Sterilization of Domestic Water System:

1. General: Upon completion of tests and necessary replacements, thoroughly flush and disinfect domestic water piping.
2. Method: After thoroughly flushing system with water to remove sediment, fill system with a solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 3 hours. After retention, drain, reflush and return system to service.
3. Certification: Provide copy of domestic water chlorination certificate in each operations and maintenance manual.
- ~~△ 4. Provide water line disinfections performed by a licensed contractor with training in potable water line disinfections~~
- △ 4. Provide water line disinfections performed by a D1 Water Operator licensed in the State of California.

3.6 CONDENSATE PIPING

A. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:

1. Reference Division 7.
2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

3.7 PRIMER PIPING

A. Excavation and Backfill:

1. See 3.01 B. above.

B. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in Sections if minimum head cannot be maintained in each Section. 5 PSI head to be minimum pressure at highest joint.

3.8 CLEANOUTS

A. Install in aboveground piping and building drain piping as indicated, as required by code; at each change in direction of piping greater than 135 degrees; at minimum intervals of 100-feet; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping. Select type to match adjacent building finish. Provide shop drawings to Architect to coordinate locations and types of cleanouts with Architect prior to installation.

B. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in Sections if minimum head cannot be maintained in each Section. 5 PSI head to be minimum pressure at highest joint.

C. Corrosive Soil Conditions:

1. Wrap steel, iron, copper or other metal piping materials/fittings with Protecto Wrap 200, 30 mils or greater. Maintain a 1/2-inch overlap and install per manufacturer's requirements.
2. Provide epoxy coated cast iron pipe and fittings for drainage systems.

- D. Cast-Iron Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.

END OF SECTION

**SECTION 223000
PLUMBING EQUIPMENT**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Water Heaters Tank-Less Electric
 - 2. Commercial High Efficiency Storage Type Gas Water Heaters
 - 3. Domestic Expansion Tanks Non-ASME
 - 4. Domestic Circulation Pump
 - 5. Grease Interceptors

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Seismic anchor details and calculations signed and stamped by licensed California structural engineer with equipment data.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. NSF 61, Annex G compliant.
 - 2. ISO 9001 Certified.
 - 3. IAPMO Low Lead Certification
- C. Products approved for installation by state authorizing agency, no exceptions.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Water Heaters Tank-Less Electric:
 - 1. Chronomite InstaFlow Micro Model M
 - 2. EEMax

3. Steibel Eltron
 4. Or approved equivalent.
- B. Commercial High Efficiency Storage Type Gas Water Heaters:
1. Bradford White Series
 2. AO Smith BTH
 3. LAARS UHE
 4. State SUF
 5. Or approved equivalent.
- C. Domestic Expansion Tanks Non-ASME:
1. Bell and Gossett Series PT
 2. American Wheatly
 3. Amtrol
 4. Armstrong
 5. Watts
 6. Or approved equivalent.
- D. Domestic Circulation Pumps:
1. Bell and Gossett Series PL
 2. Armstrong
 3. Grundfos
 4. Paco
 5. Taco
 6. Or approved equivalent.
- E. Grease Interceptors:
1. Zurn Series 1171-1170
 2. Thermaco
 3. Rockford
 4. Highland
 5. Smith
 6. Josam
 7. Wade
 8. Watts
 9. Or approved equivalent.

2.2 GENERAL

- A. Reference drawings for capacities and specific model numbers.

2.3 WATER HEATERS TANK-LESS-ELECTRIC

- A. System: Domestic water.
- B. Factory assembled packaged tank-less electric water heater utilizing microprocessor for temperature control. Heat water ways with stainless steel coils. 150 PSI working pressure. Cast aluminum or steel jacket with baked enamel finish. Pilot light to indicate when unit is operating. Prewire heaters ready for single electrical connection and bear UL label. Heater capable of operation within minimum and maximum operating flow rates and pressures of fixtures served and system operating pressure

2.4 COMMERCIAL HIGH EFFICIENCY STORAGE TYPE GAS WATER HEATERS

- A. System: Domestic Hot Water.
- B. Provide two gas fired storage high efficiency (98 percent) water heaters with capacities as indicated on Contract Documents. System to deliver minimum 120 degrees F hot water to tenants.
- C. Water Heaters in accordance with certified UL volume III tests and ASHRAE 90.1-2010. Maximum supply gas pressure to heater 13.8 inches WC (0.5 PSI).
- D. Water Heaters factory provided with an CSA (AGA) electronic intermittent gas ignition, gas pressure regulator and pilot filter, coated steel burners, draft diverter and flue damper; 120 volt, 60 Hz, single phase electrical connection.
- E. Water Heaters factory provided with 2 3/4-inches by 3 3/4-inches hand hole cleanout listed by Underwriters Laboratories. Controls include, upper and lower thermostats, combination temperature and pressure gauge, low water, CSA (AGA) and ASME rated temperature and pressure relief valve, and draft regulator. Control compartment door be hinged for easy access. Heater(s) be equipped with multiple anodes for cathodic protection.
- F. Water Heaters be insulated with vermin-proof glass fiber insulation, R 16 Value minimum. Outer jacket to have a baked enamel finish over a bonderized undercoating.
- G. Internal surfaces of water heaters exposed to water be glass-lined with alkaline borosilicate, nickelous oxide composition that has been fused to steel by firing at temperature range of 1400 degrees F to 1600 degrees F.
- H. Coordinate exact location of units and electrical characteristics with Division 26, Electrical work.
- I. Provide seismic anchor calculations for this equipment, stamped and signed by Licensed Oregon State Structural Engineer.
- J. Warranty: Three year unconditional tank replacement, one year on parts and devices.

2.5 DOMESTIC EXPANSION TANKS NON-ASME

- A. Welded steel, constructed, tested and stamped in accordance with IAPMO Standards for working pressure of 125 PSI. Support floor mounted tanks with steel legs or base. Provide single flexible diaphragm securely sealed into tank to separate air charge from system water, to maintain design expansion capacity. Provide pressure gauge and air-charging fitting, and drain fitting. Diaphragm: Removable and replaceable in line.

2.6 DOMESTIC CIRCULATION PUMPS CP-1

- A. System: Domestic water.
- B. Provide in-line factory tested pumps, cleaned, and painted with enamel prior to shipment. Pumps be rated for domestic water. Provide pumps of same type by same manufacturer.
- C. Type: Horizontal, oil-lubricated, designed for 150 PSI working pressure, 225F continuous water temperature.
- D. Body: bronze or stainless steel construction.
- E. Shaft: stainless or carbon steel, ground and polished, integral thrust collar.
- F. Bearings: Two horizontal sleeve sealed steel bearings permanently lubricated designed to circulate oil.
- G. Seal: Mechanical, with carbon seal face rotating against ceramic seat.
- H. Face plate: Stainless steel.

- I. Motor: Nonoverloading at any point on pump curve, open, drip-proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.
- J. Elastomers: EPDM.
- K. Provide Honeywell 115 volt immersion aquastat set at 115 or 118 degrees F.
- L. Option. Pump maybe operated from Building Automation System. Coordinate installation of additional devices with controls contractor.

2.7 GREASE INTERCEPTORS

- A. Interior and exterior acid resistant coated, steel or stainless steel, grease interceptor, gasketed nonskid locking cover. Cascade bottom. Internal air relief, visible double wall trap, removable baffles. Clamping ring and anchor flange. Grease draw-off piping, flexible hose and valve Zurn Z1108/Z1108-L remote in line, flow control fitting. Provide extension where required by structural features or depth of piping.
- B. Interceptor installed flush with finish floor unless specifically directed otherwise by Architect or as detailed on Drawings.

PART 3 - EXECUTION

3.1 GENERAL

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- C. Orients so controls and devices needing service and maintenance have adequate access.
- D. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.
- E. Connect water piping to units with shutoff valves and unions.
- F. Equipment Rigging: Heavy duty rigging eye bolts for Crosby Group swivel hoist rings installed over pump access covers for removal or maintenance.
- G. Garbage Disposal:
 1. General: Install complete, food waste disposal system including water, waste connections, electrical connection including associated control devices.
 2. Set devices and adjust any support or mounting assemblies per manufacturers recommendations.
 3. Water supplies, as applicable are to be provided with shut-off valves, solenoid valves, backflow preventers and water hammer arrestors.
 4. Coordinate power requirements and connection methods with division 26.
- H. Equipment Start-Up:
 1. Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls.
 2. Start-up performed by authorized manufacturer's representative or agent. Provide credentials of start-up personnel to Architect and Owner's Representative for approval.
 3. Remove and replace filters when start-up testing is executed.
 4. Manufacturer adjusts operating parameters of equipment to compensate to elevation of 500-feet above sea level.

5. Architect, Commissioning Agent, and Owner's Representative will be notified 10 days prior to start-up and will be present at start-ups.
 6. Provide written report from manufacturer's representative on results of start-up within 48 hours.
 7. Technical Training of maintenance staff includes two hours minimum per each piece of equipment.
 8. Seismic Verification:
 - a. Contractor will retain structural engineer who will submit stamped and signed anchoring and restraint details on plumbing equipment with submittal data in accordance with Division 22, Plumbing requirements.
 - b. Contractor's Structural Engineer will test and verify in writing that seismic restraints have been installed in accordance with their details.
- I. Boiler/Water Heater/Gas Shutdown:
1. Provide CSD.1 compliant controls.
 2. Remote switch: Install shutdown switch. Install pushbutton under clear, impact-resistant flip lid. Provide red phenol label "Emergency Shutdown" locate label above pushbutton. Pushbutton to be mounted by latch side of each boiler/mechanical room door within interior of the room, unless otherwise directed by AHJ. Provide electrical wiring and raceway as necessary for installation. Provide additional relays and wiring to cut power to gas solenoid valves in the room not integral to boilers. Reference drawings for gas solenoid valve locations.

3.2 WATER HEATERS TANK-LESS ELECTRIC

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- C. Orients so controls and devices needing service and maintenance have adequate access.
- D. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.
- E. Connect water piping to units with shutoff valves and unions.

3.3 COMMERCIAL HIGH EFFICIENCY STORAGE TYPE GAS WATER HEATERS

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- C. Orients so controls and devices needing service and maintenance have adequate access.
- D. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.
- E. Connect water piping to units with shutoff valves and unions.
- F. Equipment Start-Up:
 1. Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls.
 2. Start-up performed by authorized manufacturer's representative or agent. Provide credentials of start-up personnel to Architect and Owner's Representative for approval.
 3. Remove and replace filters when start-up testing is executed.

4. Manufacturer adjusts operating parameters of equipment to compensate to elevation of 500-feet above sea level.
5. Architect, Commissioning Agent, and Owner's Representative will be notified 10 days prior to start-up and will be present at start-ups.
6. Provide written report from manufacturer's representative on results of start-up within 48 hours.
7. Technical Training of maintenance staff includes two hours minimum per each piece of equipment.
8. Seismic Verification:
 - a. Contractor will retain structural engineer who will submit stamped and signed anchoring and restraint details on plumbing equipment with submittal data in accordance with Division 22, Plumbing requirements.
 - b. Contractor's Structural Engineer will test and verify in writing that seismic restraints have been installed in accordance with their details.

3.4 DOMESTIC EXPANSION TANKS NON-ASME

- A. Precharge tank per manufacturers recommendation.
- B. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- C. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- D. Orients so controls and devices needing service and maintenance have adequate access.
- E. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.
- F. Connect water piping to units with shutoff valves and unions.

3.5 DOMESTIC CIRCULATION PUMPS CP-1

- A. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Orients so controls and devices needing service and maintenance have adequate access.
- C. Connect water piping to units with shutoff valves and unions.
- D. Equipment Start-Up:
 1. Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls.
 2. Architect, Commissioning Agent, and Owner's Representative will be notified 10 days prior to start-up and will be present at start-ups.
 3. Seismic Verification:
 - a. Contractor will retain structural engineer who will submit stamped and signed anchoring and restraint details on plumbing equipment with submittal data in accordance with Division 22, Plumbing requirements.
 - b. Contractor's Structural Engineer will test and verify in writing that seismic restraints have been installed in accordance with their details.

3.6 GREASE INTERCEPTORS

- A. Provide and install per local ordinances/FOG programs.

B. Install per manufacturers recommendations.

END OF SECTION

SECTION 224000 PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. General Plumbing Fixtures:
 - a. China Fixtures, White Only
 - b. Faucet Fittings
 - c. Fiberglass Fixtures, White Only
 - d. Molded Resin or Stone Fixtures
 - e. Shower Valves
 - f. Stainless Steel Fixtures
 - g. Thermostatic Mixing Valves
 - h. Trench Drains
 - 2. Carriers
 - 3. Fixture Trim
 - 4. Floor Drains
 - 5. Floor Sinks
 - 6. Flushometers - Water Closet/Urinal
 - 7. Hose Bibbs
 - 8. Kitchen Equipment
 - 9. Water Closet Seats
 - 10. Drain Boxes

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Comply with lead free (less than or equal to 0.25 percent) products in drinking water systems.
 - 2. NSF 61, Annex G, Drinking Water System Components, Compliant.
 - 3. ISO 9001, Quality Management Standard Certified.
 - 4. IAPMO Low Lead Certification
 - 5. Provide fixtures, faucets and accessories to meet barrier free requirements of the governing code with respect to plumbing fixtures provided for the physically handicapped.
 - 6. Items approved for use by State of California.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. "Or approved equivalent" as defined in 22 00 00, General Plumbing Requirements. Substitution process requirements apply to approved equivalent products.
- B. General Plumbing Fixtures: See Schedule on Drawings for type.
 - 1. China Fixtures - White Only:
 - a. American Standard
 - b. Briggs
 - c. Crane
 - d. Eljer
 - e. Kohler
 - f. Universal-Rundle
 - g. Or approved equivalent.
 - 2. Faucet Fittings:
 - a. Private:
 - 1) Chicago
 - 2) Delta Commercial
 - 3) Moen
 - 4) Speakman
 - 5) Symmons
 - 6) T&S Brass
 - 7) Or approved equivalent.
 - b. Public:
 - 1) American Standard
 - 2) Chicago
 - 3) Delta Commercial
 - 4) Moen Commercial
 - 5) Sloan
 - 6) Symmons
 - 7) T & S Brass
 - 8) Or approved equivalent.
 - 3. Fiberglass Fixtures - White Only:
 - a. Aqua-Glass
 - b. Briggs
 - c. Crane
 - d. Fiber-Fab
 - e. Hytec
 - f. Mustee
 - g. Universal-Rundle
 - h. Or approved equivalent.
 - 4. Molded Resin or Stone Fixtures:
 - a. Fiat
 - b. Mustee
 - c. Stern Williams
 - d. Or approved equivalent.
 - 5. Shower Valves:
 - a. Acorn
 - b. Chicago
 - c. Delta
 - d. Moen

- e. Powers
- f. Symmons
- g. Or approved equivalent.
- 6. Stainless Steel Fixtures:
 - a. Elkay
 - b. Haws
 - c. Just
 - d. Or approved equivalent.
- 7. Thermostatic Mixing Valves:
 - a. Bradley
 - b. Powers
 - c. Symmons
 - d. Or approved equivalent.
- 8. Trench Drains:
 - a. Channel-Slope
 - b. JR Smith
 - c. PolyDrain
 - d. Polycast
 - e. Quazite
 - f. Zurn
 - g. Or approved equivalent.
- C. Carriers:
 - 1. JR Smith
 - 2. Zurn
 - 3. Or approved equivalent.
- D. Fixture Trim:
 - 1. McGuire
 - 2. Or approved equivalent.
- E. Floor Drains:
 - 1. Mifab
 - 2. Sioux Chief
 - 3. Smith
 - 4. Wade
 - 5. Watts
 - 6. Zurn
- F. Floor Sinks:
 - 1. Commercial Enameling
 - 2. Mifab
 - 3. Sioux Chief
 - 4. Smith
 - 5. Wade
 - 6. Watts
 - 7. Zurn
 - 8. Or approved equivalent.
- G. Flushometers - Water Closet/Urinal:
 - 1. Delaney
 - 2. Sloan
 - 3. Zurn
 - 4. Or approved equivalent.

- H. Hose Bibbs:
 - 1. Chicago
 - 2. JR Smith
 - 3. Mifab
 - 4. Wade
 - 5. Woodford
 - 6. Zurn
 - 7. Or approved equivalent.
- I. Kitchen Equipment:
 - 1. No products specified. See Part 3 "Kitchen Equipment" article below for additional information.
- J. Water Closet Seats:
 - 1. Bemis
 - 2. Or approved equivalent.
- K. Drain Boxes:
 - 1. Sioux Chief
 - 2. Or approved equivalent.

2.2 GENERAL PLUMBING FIXTURES

- A. Review substitution request requirements in Division 01, General Requirements and 22 00 00, Plumbing General Requirements.
- B. Reference Architectural Details for mounting height and location of fixtures.
- C. Provide factory fabricated fixtures of type, style and material indicated on the plumbing fixture connection schedule shown on the Drawings. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by manufacturer, or required for complete installation. Where more than one type is indicated, selection is installer's option; but, fixtures of same type must be furnished by a single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.
- D. Provide fixtures complete with fittings, supports, fastening devices, bolt caps, faucets, valves, traps, stops and appurtenances.
- E. Plumbing Fixture Flow Rates:
 - 1. Water Closets: Single flush 1.28 GPF or dual flush at 1.6/1.1 GPF.
 - 2. Lavatories in public core areas to be set for 0.5 GPM MAX. Other lavatories to be 1.0 GPM flow.
 - 3. Sinks to be set for 1.5 gpm flow max.
 - 4. Showers factory set at a maximum of 1.8 - 2 GPM flow.

2.3 CARRIERS

- A. Wall Hung Water Closets:
 - 1. Vertical: Zurn Z-1204-N4-XH-50 or Z-1204-ND4-XH-50 (JR Smith 230y-MS4-M12/230DY-M54-M12). Adjustable vertical load siphon jet with 300 lb. capacity.
 - 2. Horizontal: Zurn ZE-1203-N4-XH-50 or ZE-1203-ND4-XH-50 (JR Smith 220 R/L-Y-M54-M12/220DY-M5-M12). Adjustable horizontal siphon jet with 300 lb. load capacity.
- B. Wall Hung Urinal: Zurn Z-1218-WS. (JR Smith 913). Coupling type or plate type with bearing plate 300 lb. capacity.

- C. Wall Hung Lavatory: Zurn Z-1231 (D). (JR Smith 700). Connected arm or Plate type, 250 lb. capacity.
- D. Wall Hung Service Sink: Zurn Z-1218. (JR Smith 913/914). Coupling type.
- E. Wall Hung Drinking Fountain: Z-1225-BL (JR Smith 834-97-98). Plate type.

2.4 FIXTURE TRIM

- A. Traps: Provide heavy duty commercial grade traps on fixtures except fixtures with integral traps. Exposed traps will be chromium plated cast brass or 17 gauge chromium plated brass tubing.
 - 1. Sink: McGuire 8912-C-DF.
 - 2. Lavatory: McGuire 8902-C-DF.
- B. Supplies and Stops: Lead free heavy duty commercial grade, chrome plated with brass stems. Stops: Loose Key type.
 - 1. Lavatory: McGuire LFH 2165 CK
 - 2. Sink: McGuire LFH 2167 LK
 - 3. Water Closets: McGuire
- C. Grid strainer: McGuire 155A.
- D. Sink strainer: McGuire 152N.
- E. Trim barrier-free wrap for P-traps and supplies by McGuire, Pro-Wrap, Plumberex or True-bro.
- F. Escutcheons: McGuire wrought brass deep bell.
- G. Wax Rings and Toilet Bolts: WM Harvey No Seep No. 1 053065-N.

2.5 FLOOR DRAINS

- A. See Schedule on Drawings for types.

2.6 FLOOR SINKS

- A. See Schedule on Drawings for types.
- B. Plastic components are not allowed.

2.7 FLUSHOMETERS - WATER CLOSET/URINAL

- A. See Schedule on Drawings for types.

2.8 HOSE BIBBS

- A. See Schedule on Drawings for types.

2.9 KITCHEN EQUIPMENT

- A. No products specified. See Part 3 "Kitchen Equipment" article below for additional information.

2.10 WATER CLOSET SEATS

- A. See Schedule on Drawings for type.

2.11 DRAIN BOXES:

- A. See Schedule on Drawings for Type.

PART 3 EXECUTION

3.1 GENERAL PLUMBING FIXTURE INSTALLATION INFORMATION

A. Verification of Conditions:

1. Examine rough-in work of water supply and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures.
2. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.
3. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings and pertinent codes and regulations, design and referenced standards.
4. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.
5. Install a stop valve in a readily accessible location in water connection to each fixture.
6. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
7. Seal fixtures to walls and floors using silicone sealant Dow Corning No. 780 or approved equivalent. Match sealant color to fixture color.
8. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.
9. Inspect each unit for damage prior to installation. Replace damaged fixtures.
10. Replace washers or cartridges of leaking or dripping faucets and stops.
11. Clean fixtures, trim and strainers using manufacturer's recommended cleaning methods and materials.
12. During construction, cover installed fixtures, drains, sinks and water coolers with cardboard and wrap with sheet plastic.
13. Provide trap primers for floor drains, floor sinks, trench drains and hub drains.
14. Install roof and overflow roof drains per architectural details. Cover drains during roof construction to protect drain. Provide offsets or expansion joints at each roof/overflow drain.
15. Do not use lead flashing.

B. Owner Furnished Equipment:

1. Rough-in and make final connections to Owner furnished equipment. Provide necessary items to complete installation.
2. Comply with requirements of this Section and Drawings for installation procedures.

C. Adjusting and Cleaning:

1. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation. Adjust water pressure at drinking fountains, faucets, shower valves and flush valves to provide proper flow stream and specified GPM. Repair leaks at faucets and stops.

D. Extra Stock:

1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner.

E. Field Quality Control:

1. Upon completion of installation of plumbing fixtures, test fixtures to demonstrate capability and compliance with Specifications. Correct or replace malfunctioning units at site, then retest to demonstrate compliance.

F. Protection:

1. Protect fixtures and equipment from damage. Cover finished fixtures with cardboard and sheet plastic. Fixtures are not to be used during construction. Replace damaged items with new.

3.2 CARRIERS INSTALLATION

- A. Install components in accordance with manufacturers instructions and approved product data submittals.
- B. Set plumb, level and rigid.
- C. Coordinate wall thickness so carrier has adequate depth to be concealed.

3.3 FIXTURE TRIM INSTALLATION

- A. Install components in accordance with manufacturers instructions and approved product data submittals.
- B. Set plumb, level and rigid.

3.4 FLOOR DRAINS INSTALLATION

- A. Install components in accordance with manufacturers instructions and approved product data submittals.
- B. Set plumb, level and rigid.

3.5 FLOOR SINK INSTALLATION

- A. Install components in accordance with manufacturers instructions and approved product data submittals.
- B. Set plumb, level and rigid. Set fixture rim/grate flush with surrounding finish surface unless specifically noted otherwise.

3.6 FLUSHOMETERS - WATER CLOSET/URINAL INSTALLATION

- A. Install components in accordance with manufacturers instructions and approved product data submittals.
- B. Set plumb, level and rigid. Set fixture rim/grate flush with surrounding finish surface unless specifically noted otherwise.

3.7 HOSE BIBB INSTALLATION

- A. Install components in accordance with manufacturers instructions and approved product data submittals.
- B. Set plumb, level and rigid.

3.8 KITCHEN EQUIPMENT INSTALLATION

- A. Install components in accordance with manufacturers instructions and approved product data submittals.
- B. Furnish and install shutoff valves, pressure regulators, shock arrestors, vacuum breakers, strainers, indirect waste piping, backflow preventers, and other devices or piping which are not furnished with kitchen equipment or shown on Drawings.
- C. Set plumb, level and rigid.

3.9 WATER CLOSET SEAT INSTALLATION

- A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

3.10 DRAIN BOX INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

END OF SECTION

SECTION 230000
HEATING, VENTILATING AND AIR CONDITIONING (HVAC) BASIC
REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in 23 00 00, HVAC Basic Requirements applies to Division 23, HVAC work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of heating, ventilating and air conditioning systems for proposed project.
- B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. Definitions:
 - 1. Provide: To furnish and install, complete and ready for intended use.
 - 2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
 - 3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work provided.
 - 4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
 - 5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.2 RELATED SECTIONS:

- A. Contents of Section applies to Division 23, HVAC Contract Documents.
- B. Related Work:
 - 1. Additional conditions apply to this Division including, but not limited to:
 - a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - b. Drawings
 - c. Addenda
 - d. Owner/Architect Agreement
 - e. Owner/Contractor Agreement
 - f. Codes, Standards, Public Ordinances and Permits

1.3 REFERENCES AND STANDARDS

- A. References and Standards per Division 01, General Requirements, individual Division 23, HVAC Sections and those listed in this Section.
- B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 - 1. State of California:
 - a. CBC California Building Code
 - b. CEC California Electrical Code

- c. CEC T24 California Energy Code Title 24
- d. CFC California Fire Code
- e. CMC California Mechanical Code
- f. CPC California Plumbing Code
- g. CSFM California State Fire Marshal
- h. DSA Division of State Architect Regulations and Requirements

C. General: Reference standards and guidelines include but are not limited to the latest adopted editions from:

1. ABA Architectural Barriers Act
2. ABMA American Bearing Manufacturers Association
3. ADA Americans with Disabilities Act
4. AHRI Air-Conditioning Heating & Refrigeration Institute
5. AMCA Air Movement and Control Association
6. ANSI American National Standards Institute
7. ASCE American Society of Civil Engineers
8. ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers
9. ASHRAE Guideline 0, The Commissioning Process
10. ASME American Society of Mechanical Engineers
11. ASPE American Society of Plumbing Engineers
12. ASSE American Society of Sanitary Engineering
13. ASTM ASTM International
14. AWWA American Water Works Association
15. CFR Code of Federal Regulations
16. CGA Canadian Gas Association
17. CHPS Collaborative for High Performance Schools
18. CISPI Cast Iron Soil Pipe Institute
19. CSA CSA International
20. EPA Environmental Protection Agency
21. ETL Electrical Testing Laboratories
22. FDA Food and Drug Administration
23. FM FM Global
24. GAMA Gas Appliance Manufacturers Association
25. HI Hydraulic Institute Standards
26. IAPMO International Association of Plumbing & Mechanical Officials
27. IFGC International Fuel Gas Code
28. ISO International Organization for Standardization
29. MSS Manufacturers Standardization Society
30. NEC National Electric Code
31. NEMA National Electrical Manufacturers Association
32. NFPA National Fire Protection Association
33. NFGC National Fuel Gas Code
34. NRCA National Roofing Contractors Association
35. NSF National Sanitation Foundation
36. OSHA Occupational Safety and Health Administration
37. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
38. TEMA Tubular Exchanger Manufacturers Association
39. TIMA Thermal Insulation Manufacturers Association
40. UL Underwriters Laboratories, Inc.

41. USDA United States Department of Agriculture

- D. See Division 23, HVAC individual Sections for additional references.
- E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.
- F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.
- G. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.4 SUBMITTALS

- A. See Division 01, General Requirements for Submittal Procedures as well as specific individual Division 23, HVAC Sections.
- B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.
- C. In addition:
 - 1. "No Exceptions Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
 - 2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
 - 3. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 23, HVAC Sections.
 - 4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
 - a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
 - b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 23, HVAC Specification Sections for specific items required in product data submittal outside of these requirements.
 - c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
 - d. For vibration isolation of equipment, list make and model selected with operating load and deflection.
 - e. See Division 23, HVAC individual Sections for additional submittal requirements outside of these requirements.

5. Maximum of two reviews of submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
6. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet Section 230548, Vibration and Seismic Controls for HVAC Equipment. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
7. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required by Division 23, HVAC Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
8. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
9. Substitutions and Variation from Basis of Design:
 - a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
 - b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.
10. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, equipment, ductwork and piping layout plans, and control wiring diagrams. Reference individual Division 23, HVAC Specification Sections for additional requirements for shop drawings outside of these requirements.
 - a. Provide Shop Drawings indicating access panel locations for items that require Code or maintenance access, size and elevation for approval prior to installation.
11. Samples: Provide samples when requested by individual Sections.
12. Resubmission Requirements:
 - a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
 - 1) Resubmit for review until review indicates no exceptions taken or make "corrections as noted".
 - 2) When submitting drawings for Engineers re-review, clearly indicate changes on drawings and "cloud" any revisions. Submit a list describing each change.
13. Operation and Maintenance Manuals, Owners Instructions:
 - a. Submit, at one time, one bound copy and electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
 - 1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
 - 2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled

- equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.
- 3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Sections.
 - 4) Include product certificates of warranties and guarantees.
 - 5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
 - 6) Include copy of startup and test reports specific to each piece of equipment.
 - 7) Include copy of final air and water systems balancing log along with pump, fan and distribution system operating data.
 - 8) Include commissioning reports.
 - 9) Include copy of valve charts/schedules.
 - 10) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
- b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 23 00 00, HVAC Basic Requirements Article titled "Demonstration".
 - c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.
14. Record Drawings:
- a. Maintain at site at least one set of drawings for recording "As-constructed" conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
 - b. Record Drawings are to include equipment and fixture/connection schedules, control dampers, fire smoke dampers, fire dampers, valves, bottom of pipe, duct and equipment elevations and dimensioned locations for all distribution systems (hydronic and air). Invert elevations and dimensioned locations for underground systems below grade to 5-feet outside building that accurately reflect "as constructed or installed" for project.
 - c. At completion of project, input changes to original project CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
 - d. See Division 23, HVAC individual Sections for additional items to include in record drawings.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed to conform with all local, State, Federal and other applicable laws and regulations.
- B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.
- C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

- D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- E. UL and CSA Compliance: Provide products which are UL listed.
- F. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.
- G. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.

1.6 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Contracting and Procurement Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.7 COORDINATION DOCUMENTS

- A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, equipment, fire sprinklers, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
- B. Advise Architect in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
- C. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.
- D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide like items from one manufacturer, including but not limited to pumps, fans, valves, control devices, air handlers, vibration isolation devices, etc.

2.2 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities.
- B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
- C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

D. Hazardous Materials:

1. Comply with local, State of California, and Federal regulations relating to hazardous materials.
2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 23, HVAC Sections. In absence of specific requirements in Division 01, General Requirements, comply with the following:
1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
 - a. Ceiling access panels to be minimum 24-inch by 24-inch required and approved size.
 - b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
 - c. Provide two keys for each set of keyed cylinder type locks.
 - d. Manufacturers and Models:
 - 1) Drywall: Karp KDW.
 - 2) Plaster: Karp DSC-214PL.
 - 3) Masonry: Karp DSC-214M.
 - 4) 2 hour rated: Karp KPF-350FR.
 - 5) Manufacturers: Milcor, Elmdor, Acudor or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Install equipment having components requiring access (i.e., drain pans, drains, control operators, valves, motors and vibration isolation devices) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.
- C. Install equipment and products complete as directed by manufacturer's installation instructions including all appurtenances recommended in manufacturer's installation instructions, at no additional charge to Owner. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.
- D. Earthwork:
1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork Sections. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.

- b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
 - c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.
- E. Firestopping:
- 1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- F. Pipe Installation:
- 1. Coordinate work to account for expansion and contraction of piping materials and building, as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, seismic flexible joints, expansion joints, sleeves, anchors or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products and rating for coordinating installation of piping systems.
 - 2. Include provisions for servicing and removal of equipment without dismantling piping.
- G. Plenums:
- 1. Plenums: Materials within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723. Immediately notify Architect / Engineer of any discrepancy.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 230548, Vibration and Seismic Controls for HVAC Equipment, Division 13, Special Construction, Section 23 00 00, HVAC Basic Requirements and individual Division 23 HVAC Sections.
- B. Equipment Importance Factor: 1.0.
- C. General:
 - 1. Confirm Building Risk Category and Seismic Design Category with Architect.
 - 2. Earthquake resistant designs for HVAC (Division 23) equipment and distribution, i.e. motors, ductwork, piping, equipment, etc. conform to regulations of jurisdiction having authority.
 - 3. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
 - 4. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.
 - 5. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.
- D. Piping and Ductwork:
 - 1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA or local requirements.

- E. Equipment:
 - 1. Provide means to prohibit excessive motion of equipment during earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
 - 1. Underground system installation prior to backfilling.
 - 2. Prior to covering walls.
 - 3. Prior to ceiling cover/installation.
 - 4. After major equipment is installed.
 - 5. When main systems, or portions of, are being tested and ready for inspection by AHJ.
- C. Final Punch:
 - 1. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.4 CONTINUITY OF SERVICE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - 1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
 - 2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping and ductwork, and wiring to point of connection. Where existing systems are being utilized, clean existing distribution systems (ductwork, piping, fans, air handlers) prior to connecting new ductwork or piping.
 - 3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
 - a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 - 4. Organize work to minimize duration of power interruption.

3.5 CUTTING AND PATCHING

- A. Confirm Cutting and Patching requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - 1. Proposed floor cutting/core drilling/sleeve locations to be approved by project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
 - 2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
 - 3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.

4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

- A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.
- B. Maintain design intent where equipment other than as shown as Basis of Design in Contract Documents is provided. Where equipment requires ductwork or piping arrangement, controls/control diagrams, or sequencing different from that indicated in Contract Documents, provide at no additional cost to Owner.

3.7 DELIVERY, STORAGE AND HANDLING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage to be replaced before installation.
 2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
 3. Protect bright finished shafts, bearing housings and similar items until in service.

3.8 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.9 CLEANING

- A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

- A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.
- C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
 - 1. Do not place equipment in sustained operation prior to initial balancing of HVAC systems.
- D. Provide miscellaneous supports/metals required for installation of equipment, piping and ductwork.

3.11 PAINTING

- A. Confirm Painting requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - 1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in mechanical rooms, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
 - 2. After acceptance by Authority Having Jurisdiction (AHJ), In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
 - 3. See individual equipment Specifications for other painting.
 - 4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
 - 5. Piping and Ductwork: Clean, primer coat and paint exposed piping and ductwork on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.
 - 6. Covers: Covers such as manholes, cleanouts and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

- A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - 1. Coordinate locations/sizes of access panels with Architect prior to work.

3.13 DEMOLITION

- A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - 1. Scope:
 - a. It is the intent of these documents to provide necessary information and adjustments to the HVAC system required to meet code, and accommodate installation of new work.
 - b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
 - c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.

2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.
3. Unless specifically indicated on Drawings, remove exposed, unused ductwork and piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap and patch surfaces to match surrounding finish.
4. Unless specifically indicated on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).

3.14 ACCEPTANCE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
 - a. Testing and Balancing Reports
 - b. Cleaning
 - c. Operation and Maintenance Manuals
 - d. Training of Operating Personnel
 - e. Record Drawings
 - f. Warranty and Guaranty Certificates
 - g. Start-up/Test Document
 - h. Commissioning Reports

3.15 FIELD QUALITY CONTROL

- A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Tests:
 1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in Operation and Maintenance Manuals.
 2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 ELECTRICAL INTERLOCKS

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

END OF SECTION

**SECTION 230519
METERS AND GAUGES FOR HVAC PIPING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
1. Duct Thermometer Support Flanges
 2. Differential and Filter Pressure Gauges
 3. Pressure-Gauge Fittings
 4. Test Plugs

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Duct Thermometer Support Flanges:
1. Trerice
 2. Ashcroft
 3. Weiss
 4. Marshalltown
 5. Weksler
 6. Or approved equivalent.
- B. Differential and Filter Pressure Gauges:
1. Orange Gauges
 2. Midwest
 3. Or approved equivalent.
- C. Pressure-Gauge Fittings:

1. Omega
 2. Weiss
 3. Trerice
 4. Or approved equivalent.
- D. Test Plugs:
1. Petes Plug
 2. Or approved equivalent.

2.2 DUCT THERMOMETER SUPPORT FLANGES

- A. Description: Flanged fitting bracket for mounting in hole of duct, with threaded end for attaching thermometer.
1. Extension Neck Length: Nominal thickness of 2-inches, but not less than thickness of exterior insulation.
 2. Insertion-Neck Length: Nominal thickness of 2-inches, but not less than thickness of insulation lining.

2.3 DIFFERENTIAL AND FILTER PRESSURE GAUGES

- A. Service: Air and non-combustible, compatible gases (Natural Gas option available.)
- B. Wetted Materials: Consult factory.
- C. Housing: Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.
- D. Accuracy: Plus or minus 2 percent of full scale throughout range at 70 degrees F.
- E. Pressure Limits: Minus 20 Hg to 15 PSIG.
- F. Overpressure: Relief plug opens at approximately 25 PSIG standard gauges only.
- G. Temperature Limits: 20 to 140 degrees F.
- H. Size: 4-inch diameter dial face.
- I. Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientation.
- J. Process Connections: 1/8-inch female NPT duplicate high and low pressure taps, one pair side and one pair back.
- K. Standard Accessories: Two 1/8-inch NPT plugs for duplicate pressure taps, two 1/8-inch pipe thread to rubber tubing adapter and three flush mounting adapters with screws.

2.4 PRESSURE-GAUGE FITTINGS

- A. Valves: NPS 1/4 (DN8) brass or stainless-steel needle type.
- B. Syphons: NPS 1/4 (DN8) coil of brass turbine with threaded ends.
- C. Snubbers: ASME B40.5, NPS 1/4 (DN8) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.5 TEST PLUGS

- A. Description: Nickel-plated, brass-body test plug in NPS 1/2 (DN15) fitting.
- B. Body: Length as required to extend beyond insulation.
- C. Pressure Rating: 500 PSIG (3450 kPa) minimum.

- D. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gauge.
- E. Core Material for Air, Water, Oil and Gas: 20 to 200 degrees F (Minus 7 to plus 93 Degrees Celsius), chlorosulfonated polyethylene synthetic rubber.
- F. Test Plug Cap: Gasketed and threaded cap, with retention chain or strap.
- G. Test Kit: Pressure gauge and adapter with probe, two bimetal dial thermometers, and carrying case.
 - 1. Pressure Gauge and Thermometer Ranges: Approximately two times the system's operating conditions.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Provide instruments with scale ranges selected according to service with largest appropriate scale.

3.2 DUCT THERMOMETER SUPPORT FLANGES

- A. Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

3.3 DIFFERENTIAL AND FILTER PRESSURE GAUGES

- A. Install pressure gauge where exposure to heat and vibration are minimal and where the dial can be easily read. It is also important to install the gauge in a location with undisturbed and continuous flow of the pressure medium.
- B. Provide a needle valve or gauge cock, installed between the process and the pressure gauges.
- C. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position, visible from floor.
- D. Locations: Install in the following locations, and elsewhere as indicated.
 - 1. At each pump inlet and outlet.
 - 2. At inlet and discharge of each pressure reducing valve.
 - 3. At make-up water service outlets.
- E. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

3.4 PRESSURE-GAUGE FITTINGS

- A. Install per manufacturer's instructions and recommendations.
- B. Reference "Pressure Gauges" Article above.

3.5 TEST PLUGS

- A. Locate test plugs adjacent to thermometers and thermometer sockets, adjacent to pressure gauges and pressure gauge taps, adjacent to control device sockets, or where indicated.

END OF SECTION

**SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Balancing Valves
 - 2. Ball Valves
 - 3. Swing Check Valves
 - 4. Wafer Check Valves

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Valves: Obtain each type of valve from a single source and from a single manufacturer.
- B. Valves, General:
 - 1. Apollo
 - 2. Armstrong
 - 3. ASCO
 - 4. Cla-Val
 - 5. Conbraco
 - 6. Crane
 - 7. Clow
 - 8. Griswold
 - 9. Hammond
 - 10. Hays

11. Jenkins
12. Josam
13. Kennedy
14. Milwaukee
15. Mueller
16. Nibco
17. Red-White Valve
18. Smith
19. Stockham
20. Tour Anderson
21. Wade
22. Watts
23. Wilkins
24. Zurn
25. Or approved equivalent.

C. Balancing Valves:

1. Griswold
2. Hays
3. Armstrong CBV
4. Tour Anderson
5. Or approved equivalent.

D. Ball Valves:

1. See Valves General above.
2. NSF Valves:
 - a. Clow
 - b. Kennedy
 - c. Nibco
 - d. Or approved equivalent.

E. Swing Check Valves:

1. See Valves General above.

F. Wafer Check Valves:

1. See Valves General above.

2.2 VALVES - GENERAL

A. General:

1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6 inches and smaller. Provide gear operators for quarter-turn valves 8 inches and larger and plug valves 5 inches and larger. Provide chain-operated sheaves and chains for overhead valves installed over 5 feet above finished floor.
3. Valve Identification: Manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

B. Valves in Insulated Piping: With 2-inch stem extension and following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied.

- a. Basis of Design Product: Subject to compliance with requirements. Provide NIBCO NIB-SEAL handle extension or comparable product by one of the following.
 - 1) Conbraco Industries, Inc.: Apollo Div.
- C. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves, ASME B16.5 for steel valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With thread according to ASME B1.20.1.
- D. Valve Bypass and Drain Connections: MSS SP-45.
- E. Building Service:
 - 1. Shutoff and Isolation Valves:
 - a. Pipe Sizes 3 Inches and Smaller: Ball valve.
 - 2. Drain Service; All Pipe Sizes: Ball valves.
 - 3. Strainer Blow-Off: Ball valve.
 - 4. Check Valves: Swing, Wafer, or Lift.

2.3 BALANCING VALVES

- A. Maximum 125 PSIG System Working Pressure.
- B. Manual Set Balancing Valves:
 - 1. Valves are to be of the "Y" pattern, equal percentage globe-style and provide three functions:
 - a. Precise flow measurement.
 - b. Precision flow balancing.
 - c. Positive drip-tight shutoff.
 - 2. Valve to provide multi-turn, 360 degree adjustment with micrometer type indicators located on the valve handwheel. Valves have a minimum of five full 360 degree handwheel turns. 90 degree style ball valves are not acceptable. Valve handle to have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. Valves to be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi to have two 1/4-inch threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. The valve body, stem and plug to be brass. The handwheel to be high-strength resin.
- C. Automatic Balance Valve:
 - 1. 1/2 Inch and Larger: Construction and attachment style as required by piping system. Internal working parts and removable flow cartridge to be stainless steel. Valves be factory set and automatically limit flow to specified capacities with 5 percent plus or minus accuracy over entire operating pressure differential.

2.4 BALL VALVES

- A. All ball valves on brazed piping are to be three-piece.
- B. 2-1/2 Inches and Smaller: MSS SP-110, 400-600 PSI, two-piece full port ball configuration, bronze body, extended soldered ends for copper pipe and threaded ends for iron pipe, brass or stainless steel ball, Teflon seat, brass stem, or extended steel handle. Apollo 70CLF 100 Series two-piece.
- C. Full Port Ball Valve: 2- to 4-inch ductile iron, ASTM A536, micro finish steel chrome plated or stainless steel ball and stem. TFE seats, 600 PSI.

2.5 SWING CHECK VALVES

- A. 2 Inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413. MSS SP-80, Type 4.

- B. Gruvlok Check Valve: Horizontal installation. Working pressure to 300 PSI. Ductile body, ASTM A536, and stainless clapper, EPDM, nitrile or optional viton bumper and bonnet seals. Stainless wetted parts.

2.6 WAFER CHECK VALVES

- A. Twin disc, Class 125 spring actuated designed to be installed with gaskets between two standard Class 125 flanges. 200 PSI, cast iron body, aluminum bronze disc. Nibco W-920-W.
- B. Check Valve: PPS coated ductile iron body, ASTM A536, aluminum bronze nonslamming disc, stainless steel spring and shaft. Rubber seat for intended service.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle and globe valves closed to prevent rattling.
 - 4. Set ball open to minimize exposure of functional surfaces.
 - 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Do not attempt to repair defective valves; replace with new valves.
- E. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate Sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
- F. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter and cap on chain for each valve that must be installed with stem below horizontal plane. Ensure installation provides full stem movement.
- G. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.
- H. Mechanical Actuators: Install with chain operators where indicated. Extend chains to 5-feet above floor and hook to clips to clear aisle passage.
- I. Stem Selection: Outside screw and yoke stems, except provide inside screw, nonrising stem where space prevents full opening of OS&Y valves.
- J. Seats: Renewable seats, except where otherwise indicated.
- K. When soldering, use paste flux that is approved by the manufacturer for use with lead-free alloys.
- L. Valve Adjusting and Cleaning:
 - 1. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.
- M. General Requirements for Valve Applications:

1. If valve applications are not indicated, use the following:
 - a. Shutoff Service: Ball or butterfly, gate valves.
 - b. Throttling Service: Balancing valves.
2. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
3. Valves, except wafer types, with the following end connections.
 - a. For Copper Tubing 2 Inches and Smaller: Threaded ends.

3.2 BALANCING VALVES

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations.
- C. Purge and clean all piping to be connected to valve.
- D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.
- E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.
- F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.
- G. Install with flow in the direction of the arrow on the valve body and install at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream from the balancing valve should be free of any fittings. When installed, easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided. Mounting of valve in piping must prevent sediment build-up in metering ports. Install devices in accordance with manufacturer's recommendations to automatically balance water flow in piping loops as indicated.

3.3 BALL VALVES

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations.
- C. Purge and clean all piping to be connected to valve.
- D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.
- E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.
- F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.

3.4 SWING CHECK VALVES

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations.

- C. Purge and clean all piping to be connected to valve.
- D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.
- E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.
- F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.
- G. Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow. Only install where there is ten pipe diameters of straight pipe upstream of valve.

3.5 WAFER CHECK VALVES

- A. See General Installation Requirements above.
- B. Install per manufacturers recommendations.
- C. Purge and clean all piping to be connected to valve.
- D. Inspect the shipping container before unpacking to look for damage that could have occurred during reported to the transportation company immediately. After you have this visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly of valve body.
- E. Make sure to note the valves model number during the unpacking process. The model number will need to be provided when purchasing replacements parts.
- F. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.
- G. Install between two flanges in horizontal or vertical position, position for proper direction of flow.

END OF SECTION

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
1. Hangers and Supports for HVAC Piping, Ductwork and Equipment
 2. Wall and Floor Sleeves
 3. Building Attachments
 4. Flashing
 5. Miscellaneous Metal and Materials

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
1. ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.
 2. Terminology: As defined in MSS SP-90 "Guidelines on Terminology for Pipe Hangers and Supports".
 3. Install ductwork and piping per SMACNA's requirements.
 4. Hanger spacing installation and attachment to meet all manufacturers requirements and Code requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
1. Welding:
 - a. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications.
 2. Welding for Hangers:
 - a. Qualify procedures and personnel according to AWS D9.1, Sheet Metal Welding Code for duct joint and seam welding.
 3. Engineering Responsibility:
 - a. Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, duct support equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
 - 1) Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those

performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

4. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.
5. Support systems to be supplied by a single manufacturer.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 PERFORMANCE REQUIREMENTS

- A. Provide pipe, ductwork and equipment hangers and supports in accordance with the following:
 1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor is responsible for their design.
 2. Connections to structural framing not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
- B. Engineered Support Systems:
 1. Support frames such as pipe racks or stanchions for piping, ductwork and equipment which provide support from below.
 2. Equipment, ductwork and piping support frame anchorage to supporting slab or structure.
- C. Provide channel support systems, for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- D. Provide heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- E. Provide seismic restraint hangers and supports for piping, ductwork and equipment. See Section 230548.
- F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment. See Section 230548.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Hangers and Supports for HVAC Piping, Ductwork and Equipment:
 1. Anvil International
 2. B-Line Systems, Incorporated
 3. Erico Company, Incorporated
 4. Nelson-Olsen Incorporated
 5. Rilco Manufacturing Company, Incorporated
 6. Snappitz Thermal Pipe Shield Manufacturing
 7. Unistrut Corporation
 8. Or approved equivalent.
- B. Wall and Floor Sleeves:
 1. Thunderline Corporation "Link Seal".
 2. Or approved equivalent.
- C. Building Attachments:

1. Anchor-It
2. Gunnebo Fastening Corporation
3. Hilti Corporation
4. ITW Ramset/Red Head
5. Masterset Fastening Systems, Incorporated
6. Or approved equivalent.

D. Flashing:

1. Manufacturer not applicable.

E. Miscellaneous Metal and Materials:

1. Manufacturer not applicable.

2.2 HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

- A. Hanger Rods: Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.
- B. Hanger Rod Couplings: Anvil Figure 136, B-Line Figure B3220, or approved equivalent; malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.
- C. Channel Hanging System:
1. Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33, one side of channel to have a continuous slot within turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.
 2. Concrete Inserts: Malleable iron body, hot tipped galvanized finish. Lateral adjustment. MSS Type 18.
- D. Continuous Concrete Insert: Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.
- E. Pipe Hangers:
1. Pipe Rings for Hanger Rods:
 - a. Pipe Sizes 2-inches and Smaller: Adjustable swivel ring hanger, UL listed. Erico 100 or 101, Anvil Figures 69 or 104, or approved equivalent.
 - b. Pipe hangers to have same finish as hanger rods.
- F. Pipe Saddles and Shields:
1. Factory fabricated saddles or shields under piping hangers and supports for insulated piping.
 2. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12-inches in length (4-inch pipe and larger to be three times longer than pipe diameter).
- G. Riser Clamps: Steel, UL listed. MSS Type 8. Erico 510 or 511. Copper coated; Erico 368.
- H. Pipe Slides: Anvil, reinforced Teflon slide material (3/32-inch minimum thickness) bonded to steel; highly finished steel or stainless steel contact surfaces to resist corrosion; 60-80 PSI maximum active contact surface loading; steel parts 3/16-inch minimum thickness; attachment to pipe and framing by welding.
- I. Pipe Guides:
1. Furnish and install pipe guides on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides securely to pipe and structure. Contact with chilled water pipe not to permit heat to be transferred in sufficient quantity to cause condensation on any surface.

2. Furnish and install guides approximately four pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Guides are not to be used as supports and are in addition to other pipe hangers and supports.
- J. Pipe Roller Hangers: Adjustable roller hanger. Black steel yoke, cast iron roller. MSS Type 41.
- K. Below Ground Pipe Supports:
1. Pipe Hangers All Sizes: Adjustable Clevis type, Federal Specification WW-H-171 (Type 1), UL listed, stainless steel Type 304. MSS Type 1. Erico 406.
 2. Rod: 5/8-inch stainless steel Type 18-8.
 3. Eyebolt: Stainless steel Type 18-8.
 4. Nuts and Washers: Stainless steel Type 18-8.
- L. Thermal Hanger Shield Inserts:
1. 100-PSI (690-kPa) minimum compressive strength calcium silicate insulation, encased in sheet metal shield or polyisocyanurate rigid foam exceeding the load bearing weight of the pipe at the hanger point with a PVC vapor barrier.
 2. Material for Cold Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with vapor barrier or polyisocyanurate rigid foam with a PVC vapor barrier.
 3. Material for Hot Piping: Water-repellent-treated ASTM C533, Type 1 calcium silicate or polyisocyanurate rigid foam with a PVC vapor barrier.
 4. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 5. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 6. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.
 7. Thermal Hanger Shield Insulation Operating Temperature: Meet or exceed fluid temperature in pipe.
- M. Freestanding Roof Supports: Polyethylene high-density UV resistant quick "pipe" block with foam pad.

2.3 WALL AND FLOOR SLEEVES

- A. Below Grade or High Water Table Areas:
1. "Link-Seal" Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal.
 2. Provide Type S unless otherwise noted.
- B. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.
- C. Fabricated Accessories:
1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
 2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:
 - a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.
 - b. Sleeve Sizes 5-6-inches: 16 gauge.
 - c. Sleeve Sizes 7-inches and Larger: 14 gauge.
 - d. Fire-Rated Safing Material.
 - 1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 pounds per cubic foot density with melting point of 1985 degrees F and K value of 0.24 at 75 degrees F.
 - 2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100 degrees F to 1200 degrees F service with K value of 0.40 at 150 degrees F.

2.4 BUILDING ATTACHMENTS

- A. Beam Clamps:
 - 1. MSS Type 19 and 23, wide throat, with retaining clip.
 - 2. Universal Side Beam Clamp: MSS Type 20.
- B. Powder-Actuated Drive Pin Fasteners: Powder actuated type, drive pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Anchor Bolts:
 - 1. Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer. Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
 - 2. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
 - 3. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
 - 4. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.

2.5 FLASHING

- A. Steel Flashing: 26 gauge galvanized steel.
- B. Safes: 8 mil thick neoprene.
- C. Caps: Steel, 22 gauge minimum, 16 gauge at fire-resistant structures.

2.6 MISCELLANEOUS METAL AND MATERIALS

- A. General:
 - 1. Provide miscellaneous metal items specified, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on drawings or otherwise not shown on drawings that are necessary for completion of the project. Contractor is responsible for their design.
 - 2. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.
- B. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.
- C. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.
- D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.
- E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

- F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.
- G. Provide hot dipped galvanized components for items exposed to weather. Use materials compatible with system being supported (i.e. aluminum for aluminum ductwork, stainless steel for stainless steel ductwork).
- H. Use straps, threshold rods and wire with sizes required by SMACNA to support ductwork.
- I. Grout:
 1. ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 2. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 3. Properties: Nonstaining, noncorrosive, and non gaseous.
 4. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.
- B. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.
- C. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.
- D. Equipment Clearances: Do not route ductwork, equipment, or piping through electrical rooms, transformer vaults, elevator equipment rooms, IT rooms, or other electrical or electronic equipment spaces and enclosures and the like. Within equipment rooms, provide minimum 3-foot lateral clearance from all sides of electric switchgear panels. Do not route ductwork, equipment, or piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact ductwork, equipment or pipe routing to provide proper clearance with such items.

3.2 HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

- A. Hang rectangular sheet-metal ducts with a cross Sectional area of less than 7 SF with galvanized strips of No. 16 USS gauge steel 1-inch wide, and larger ducts with steel angles and adjustable hanger rods similar to piping hangers. Support at a maximum of 8-feet on center.
- B. Support horizontal ducts within 24-inches of each elbow and within 48-inches of each branch intersection.
- C. Provide aluminum supports for aluminum ductwork.
- D. Provide stainless steel supports for stainless steel ductwork.
- E. Support vertical ducts at maximum intervals of 16-feet and at each floor.
- F. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

- G. Use double nuts and lock washers on threaded rod supports.
- H. Floor supports in mechanical rooms to be elevated 1-inch above finish floor and void space filled with masonry grout.
- I. Anchor ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps to roof deck. Do not support ducts from other ducts, piping or equipment.
- J. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.
- K. Construct exterior ductwork or ductwork which is otherwise exposed to weather watertight and slope 1/4-inch per foot to avoid standing water.
- L. Exposed ductwork hung in clean areas such as sanitary areas, pharmaceutical areas, wash down areas or food process areas to be installed using double end, food grade trapeze hanger rods suitable for use with food grade strut.
- M. Channel Support System Installation:
 - 1. Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 - 2. Field assemble and install according to manufacturer's written instructions.
- N. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- O. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- P. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- Q. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping, ductwork and equipment to proper level and elevations.
- R. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.
- S. Horizontal Piping Hangers and Supports; Horizontal and Vertical Piping, and Hanger Rod Attachments:
 - 1. Factory fabricated horizontal piping hangers and supports complying with MSS SP-58, to suit piping systems and in accordance with manufacturer's published product information.
 - 2. Use only one type by one manufacturer for each piping service.
 - 3. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.
 - 4. Pipe support spacing (pipe supported in ceiling or floor-supported) to meet latest applicable Code and manufacturer's requirements.
 - 5. Provide copper-plated hangers and supports for uninsulated copper piping systems.
- T. Plumber's Tape not permitted as pipe hangers or pipe straps.
- U. Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. For horizontally hung grooved-end piping, provide a minimum of 2 hangers per pipe Section.
- V. Pipe Ring Diameters:
 - 1. Uninsulated and Insulated Pipe, Except Where Oversized Pipe Rings are Specified: Ring inner diameter to suit pipe outer diameter.

2. Insulated Piping Where Oversized Pipe Rings are Specified and Vibration Isolating Sleeves: Ring inner diameter to suit outer diameter of insulation or sleeve.
- W. Oversize Pipe Rings: Provide oversize pipe rings of 2-inch and larger size.
- X. Pipe Support Brackets: Support pipe with pipe slides.
- Y. Steel Backing in Walls: Provide steel backing in walls to support fixtures and piping hung from steel stud walls.
- Z. Pipe Guides:
1. Install on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides to pipe structure. Contact with chilled water pipe does not permit heat to be transferred in sufficient quantity to cause condensation on any surface.
 2. Install approximately four pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Do not use as supports. Provide in addition to other required pipe hangers and supports.
- AA. Heavy-Duty Steel Trapeze Installation:
1. Arrange for grouping of parallel runs of horizontal piping and support together on field fabricated, heavy-duty trapezes.
 2. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 3. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- AB. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers. Maximum spacings: MSS SP-58.
- AC. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe.
- AD. Do not support piping from other piping.
- AE. Fire protection piping will be supported independently of other piping.
- AF. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.
- AG. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping" is not exceeded.
- AH. Insulated Piping:
1. Attach clamps and spacers to piping.
 2. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 3. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 4. Do not exceed pipe stress limits according to ASME B31.9.
 5. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 6. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
 7. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields to span arc of 180 degrees.
 8. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
 9. Shield Dimensions for Pipe, not less than the following:

10. NPS 1/4 to NPS 3-1/2 (DN8 to DN 90): 12-inches long and 0.048-inch thick.
 11. NPS 4 (DN100): 12-inches long and 0.06-inch thick.
 12. NPS 5 and NPS 6 (DN125 and DN150): 18-inches long and 0.06-inch thick.
 13. NPS 8 to NPS 14 (DN200 to DN350): 24-inches long and 0.075-inch thick.
 14. NPS 16 to NPS 24 (DN400 to DN600): 24-inches long and 0.105-inch thick.
 15. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
 16. Insert Material: Length at least as long as protective shield.
 17. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- AI. Pipe Anchors: Provide anchors to fasten piping which is subject to expansion and contraction, and adjacent to equipment to prevent loading high forces onto the equipment.
- AJ. Pipe Curb Assemblies:
1. Provide prefabricated units for roof membrane and insulation penetrations related to equipment. Coordinate with roofing system. Set supports on the structural deck. Do not set supports on insulation or roofing. Provide level supports by prefabricated pitch built into the curb.
 2. Provide for piping and electrical conduit which penetrates the structural roof deck to service equipment above the roof level (i.e., piping, electrical power and control wiring). Meet requirements of roof warranty.
- AK. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.
- AL. Vertical Piping:
1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
 2. Riser clamps to be directly under fitting or welded to pipe.
 - a. Riser to be supported at each floor of penetration.
 - b. Provide structural steel supports at the base of pipe risers. Size supports to carry forces exerted by piping system when in operation.
- AM. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise.

3.3 WALL AND FLOOR SLEEVES

- A. "Link-Seal" Pipe Sleeves: Install at floor/below grade piping penetrations. Provide manufacturer's sleeve appropriate to seal type for pre-cast penetrations.
- B. Fabricated Pipe Sleeves:
1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeve diameter to be determined by local seismic clearance requirements, and by waterproofing requirements.
 2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1-inch above floor finish.
 3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
 4. Seal each end airtight with a resilient nonhardening sealer, UL listed, fire rated ASTM 814.
- C. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
1. Install fabricated pipe sleeve.

2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D. with specified material.
 3. Seal each end airtight with a resilient nonhardening UL listed fire resistant ASTM 814.
- D. Piping Penetrations Through Fire-Rated (One to Three Hour) Assemblies:
1. Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.
 2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814.

3.4 BUILDING ATTACHMENTS

- A. Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions and in accordance manufacturer's published product information.
- B. Select size of building attachments to suit hanger rods.
- C. Install concrete inserts before placing concrete.
- D. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
- E. Do not use powder-actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4-inches thick.
- F. Install within concrete or on structural steel or wood. Attachment to wood structure: Anvil side beam bracket Figure 202 for attachment to wooden beam or approved attachment for a wood structure.
- G. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.
- H. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.
- I. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-58. Install additional attachments at concentrated loads, including valves, flanges guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- K. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- L. Bolting: Provide bored, drilled or reamed holes for bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand sawn holes will not be accepted.
- M. Anchor Bolts:
 1. Install anchor bolts for mechanical equipment, piping and ductwork as required. Tightly fit and clamp base-supported equipment anchor bolts at equipment support points. Provide locknuts where equipment, piping and ductwork are hung.
 2. Anchor bolts (Cast-In-Place): Embed anchor bolts in new cast-in-place concrete to anchor equipment. Install a pipe sleeve around the anchor bolt for adjustment of the top 1/3 of the bolt embedment; sizes and patterns to suit the installation conditions of the equipment to be anchored.
- N. Testing: Test powder-actuated insert attachments with a minimum load of 100 pounds.

3.5 FLASHING

- A. Flash and counterflash where piping, ductwork and equipment passes through weather or waterproofed walls, floors, and roofs.
- B. Provide 12-inches minimum height curbs for roof-mounted mechanical equipment. Flash and counter flash with galvanized steel, soldered and waterproofed.

3.6 MISCELLANEOUS METAL AND MATERIALS

- A. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.
- B. Finishes:
 - 1. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
 - 2. Metal in Contact with Concrete, Masonry and Other Dissimilar Materials: Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
 - 3. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.
- C. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts. Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.
- E. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items, which are to be built into concrete masonry or similar construction.
- F. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.
- G. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

- H. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.
- I. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
- J. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- K. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- L. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.
- M. Provide galvanized components for items exposed to weather.

END OF SECTION

SECTION 230548
VIBRATION AND SEISMIC CONTROLS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Vibration Isolation
 - 2. Seismic Restraint Devices
 - 3. Factory Finishes
 - 4. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping and Ductwork
- B. General:
 - 1. Vibration isolation for mechanical ductwork, piping and equipment.
 - 2. Seismic restraint for mechanical ductwork, piping and equipment.
 - 3. Seismic Certification for equipment, hangers and systems
 - 4. Special inspections for systems.
- C. Scope of Work:
 - 1. Vibration isolation and seismic restraint of new equipment and systems within project boundary defined in architectural drawings.
 - 2. Vibration isolation and seismic restraint of new equipment and systems in existing buildings to points of connection with existing systems.
 - 3. Seismic restraint of existing systems and equipment shown on drawings, within project boundary defined in architectural drawings.
 - 4. Provide supplementary structural steel for seismic restraint systems. No hanging from roof deck is permitted on this project, unless specifically allowed by Structural Engineer of Record in writing prior to bid.

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Vibration Isolation:
 - a. Product Data: Provide catalog data indicating size, type, load and deflection of each isolator; and percent of vibration transmitted based on lowest disturbing frequency of equipment.
 - b. Shop Drawings: Showing complete details of construction for steel and concrete bases including:
 - 1) Fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment and cantilever loads.
 - 2) Equipment mounting holes.
 - 3) Dimensions.

- 4) Size and location of concrete and steel bases and curbs.
 - 5) Isolation selected for each support point.
 - 6) Details of mounting brackets for isolator.
 - 7) Weight distribution for each isolator.
 - 8) Details of seismic snubbers.
 - 9) Code number assigned to each isolator.
 - c. Design calculations: Provide calculations for selecting vibration isolators and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 3. Seismic Restraint:
 - a. Shop Drawings: Show compliance with requirements of Quality Assurance article of this Section. Shop drawings to be stamped by a professional Structural Engineer licensed in State of California.
 - b. Calculations: Submit seismic calculations indicating restraint loadings resulting from design seismic forces. Include anchorage details and indicate quantity, diameter and depth of penetration of anchors. Calculations certified by professional Structural Engineer licensed in State of California.
 4. Seismic Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter and depth of penetration of anchors.
 5. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y and z planes.
 6. Welding certificates.
 7. Air Mounting System Performance Certification: Include natural frequency, load and damping tests performed by an independent laboratory or acoustician.
 8. Equipment Certification: Provide seismic certification for equipment as noted in Seismic Design Summary or schedules on Drawings.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 1. Vibration Isolation:
 - a. Except for packaged equipment with integral isolators, single manufacturer selects and furnishes isolation required.
 - b. Deflections indicated on drawings are minimum actual static deflections for specific equipment supported.
 - c. Isolator Stability:
 - 1) Size springs of sufficient diameter to maintain stability of equipment being supported. Spring diameters not less than 0.8 of compressed height at rated load.
 - 2) Springs have minimum additional travel to solid equal to 50 percent of rated deflection.
 - 3) Springs support 200 percent of rated load, fully compressed, without deformation or failure.
 - d. Maximum Allowable Vibration Levels: Peak vibration velocities not exceed 0.08 in/sec. Correct equipment operating at vibration velocities that exceed this criteria.
 2. Seismic Restraint:
 - a. Code and Standard Requirements:
 - 1) Seismic restraint of equipment, piping and ductwork to be in accordance with latest enacted version of ASCE 7-10.
 - b. Seismic Design Category:
 - 1) Confirm Seismic Design Category with Architect.
 - 2) Seismic Design Category: D for mechanical equipment and systems.
 - c. Building Risk Category:

- 1) Confirm Building Risk Category with Architect.
 - d. Equipment Importance Factor: 1.0.
 - e. Certification: See Seismic Design Table or schedules on Drawings for equipment, systems and seismic-restraint devices designated to have seismic certification / qualification. Horizontal and vertical load testing and analysis performed ASCE 7-10. Anchorage systems to bear an agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing or calculations, if preapproved ratings are not available. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be sealed by qualified licensed professional engineer in State of California. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to weakest mode.
 - f. Seismic restraint and anchorage of permanent equipment and associated systems listed below to building structure be designed to resist total design seismic force prescribed in local building code:
 - 1) Floor- or roof-mounted equipment weighing 400 pounds or greater.
 - 2) Suspended, wall-mounted or vibration isolated equipment weighing 20 pounds or greater.
 - 3) In-line duct devices connected to ductwork weighing 75 pounds or greater.
 - 4) Housekeeping slabs: provide reinforcement and anchorage to building structure.
 - g. Where required, seismic sway bracing of suspended duct and piping meet following:
 - 1) Pipe and duct runs requiring seismic bracing have minimum of two traverse braces and one longitudinal brace. Longitudinal (or traverse) brace at 90 degree change in direction may act as traverse (or longitudinal) brace if located within 2-feet of change in direction.
 - 2) Seismic bracing may not pass through seismic separation joint. Pipe or duct runs that pass through seismic separation joint must be restrained within 5-feet of both sides of separation.
 - 3) Seismic brace assembly spacing not to exceed 40-feet transverse and 80-feet longitudinal.
 - h. Seismic restraints may be omitted from suspended piping and duct if following conditions are satisfied:
 - 1) For piping or ducts supported by rod hangers 12-inches or less in length from top of duct to bottom of structural support. Top connections to structure have swivel joints, eye bolts, or vibration isolation hangers for entire length of system run.
 - 2) Lateral motion of system will not cause damaging impact with surrounding systems or cause loss of system vertical support.
 - 3) System must be welded steel pipe, brazed copper pipe, sheet metal duct or similar ductile material with ductile connections.
- C. Seismic restraints, including anchors to building structure, be designed by registered professional Structural Engineer licensed in State of California. Design includes:
- 1. Number, size, capacity and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both unit to curb and curb to structure.
 - 2. Number, size, capacity and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations and test data verifying horizontal and vertical ratings of seismic restraint devices.
 - 3. Number, size, capacity and location of braces and anchors for suspended piping and ductwork on as-built plan drawings.
 - 4. Maximum seismic loads to be indicated on drawings at each brace location. Drawings bear stamp and signature of registered professional Structural Engineer who designed layout of braces.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Seismic Snubber Units: Furnish replacement neoprene inserts for snubbers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Vibration Isolation:
 - 1. Amber/Booth
 - 2. B-Line Systems, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries Inc.
 - 5. M.W. Sausse - Vibrex
 - 6. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
 - 7. Or approved equivalent.
- B. Seismic Restraint Devices:
 - 1. Amber/Booth
 - 2. B-Line Systems, Inc.
 - 3. Hilti, Inc.
 - 4. Kinetics Noise Control, Inc.
 - 5. Mason Industries, Inc.
 - 6. California Dynamics Corporation
 - 7. Cooper B-Line Tolco.
 - 8. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
 - 9. M.W. Sausse - Vibrex
 - 10. Or approved equivalent.
- C. Factory Finishes:
 - 1. Kynar 500 Fluoropolymer Coating
 - 2. Or approved equivalent.
- D. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping and Ductwork:
 - 1. Amber-Booth
 - 2. California Dynamics Corporation
 - 3. Cooper B-Line, Inc.
 - 4. Hilti, Inc.
 - 5. Mason Industries, Inc.
 - 6. Kinetics Noise Control.
 - 7. Unistrut
 - 8. ISAT, Inc.
 - 9. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
 - 10. Or approved equivalent.

2.2 VIBRATION ISOLATION

- A. Type 1 - Neoprene Pad: Natural rubber waffle pads, arranged in single or multiple layers, 3/4-inch thick per layer with pattern repeating on 1/2-inch centers; 50 durometer hardness; maximum loading 60 PSI. 1/4-inch thick steel load distribution plate between layers and between pad and equipment, factory cut to sizes matching requirements of supported equipment. Molded bridge with neoprene anchor bolt bushing and flat washer face to prevent metal to metal contact. Number of layers required for equipment scheduled. Mason Type: Super WMH.
- B. Type 2 - Neoprene Mount: Double-deflection type, with ductile-iron housing containing two separate and opposing, oil-resistant natural rubber or bridge bearing neoprene elements, factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Neoprene elements to prevent metal to metal contact during normal operation. Minimum static deflection of 0.20-inches. Mason Type: BR.
- C. Type 3 - Spring: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
 2. Minimum Additional Travel: 50 percent of required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, natural rubber or bridge bearing neoprene isolator pad attached to baseplate underside. Baseplates limit floor load to 100 PSIG (690 kPa).
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
 7. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.
 8. Mason Type: SLFH.
- D. Type 4a - Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops (out of contact during normal operation) to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, natural rubber or bridge bearing neoprene isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Restraining bolts have large rubber grommets to provide cushioning in vertical and horizontal directions. A minimum clearance of 3/8-inch maintained around restraining bolts so as not to interfere with spring action.
 2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
 3. Minimum Additional Travel: 50 percent of 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. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.
 7. Mason Type: SLR.
- E. Type 4b - Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint with neoprene acoustical cup, spring inspection ports and rebound adjustment ports.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel before contacting a resilient collar.

4. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.
 5. Mason Type: SSLFH.
- F. Type 5a - Restrained Elastomeric Hangers: Double-deflection type, with molded, oil-resistant natural rubber or bridge bearing neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Seismic rebound steel and bonded LDS rubber washer to limit upward seismic movement. Mason Type: RWHD.
- G. Type 5b- Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 15 degrees of angular hanger-rod misalignment from vertical without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
 3. Minimum Additional Travel: 50 percent of 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Mason Type: 30N.
- H. Type 5c - Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 15 degrees of angular hanger-rod misalignment from vertical without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
 3. Minimum Additional Travel: 50 percent of 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Mason Type: RW30.
- I. Type 6 - Horizontal Thrust Restraints: Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
 3. Minimum Additional Travel: 50 percent of 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

8. Mason Type: WBI or WBD
- J. Type 7 - Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on isolation material of 500 PSIG (3.45 MPa) and for equal resistance in all directions. Mason Type: ADA.
- K. Type 8 - Resilient Pipe Vertical Sliding Guide: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin be removable and reinsertable to allow for selection of pipe movement. Guides be capable of motion to meet location requirements. Mason Type: VSG. Provide pipe expansion hangers to control load shifts as the riser expands or contracts, Mason HES.
- L. Type FC-1, Flexible duct connectors. See Specification Section 23 33 00 Air Duct Accessories.
- M. Type FC-2A, Flexible Pipe Connector, Steel:
1. 321 stainless steel, close pitch, annular corrugated hose.
 2. Exterior Sleeve: 304 stainless steel, braided.
 3. Pressure Rating: 125 PSI at 70 degrees F for 12-inch and smaller pipe.
 4. Joint: ANSI Class 150 carbon steel flanges.
 5. Size: Use pipe sized units.
 6. Minimum Allowable Offset: 3/4-inch on each side of installed center line.
 7. Basis of Design: Metraflex Model MLP.
- N. Type FC-2B, Flexible Pipe Connector, Copper:
1. Inner Hose: Bronze, close pitch, annular corrugated hose.
 2. Exterior Sleeve: Braided bronze (for piping over 2-inches, to be 3 pound braided stainless steel).
 3. Minimum Allowable Pressure Rating: 125 PSI at 70 degrees F.
 4. Joint: Sweat ends.
 5. Size: Use pipe sized units.
 6. Minimum Allowable Offset: 3/8-inch on each side of installed center line.
 7. Basis of Design: Metraflex Model BBS.
- O. Type FC-2C, Flexible Pipe Connector, Gas:
1. Inner Hose: 304 stainless steel.
 2. Exterior Sleeve: Braided, 304 stainless steel.
 3. Minimum Allowable Pressure Rating: 150 PSI at 70 degrees F up to 4-inch pipe.
 4. Joint: Threaded carbon steel.
 5. Minimum Allowable Offset: 3/4-inch on each side of installed center line.
 6. Basis of Design: Metraflex GASCT.
- P. Type FC-3, Flexible Compensator, Double Sphere:
1. Body: Molded twin spherical type. Neoprene with internal cord or wire.
 2. Minimum Pressure Rating, Sizes 2-inch to 12-inch: 225 PSI at 170 degrees F.
 3. Minimum Pressure Rating, Sizes 14-inch to 20-inch: 125 PSI at 170 degrees F.
 4. Minimum Allowable Compression: 1-1/2 inches.
 5. Minimum Allowable Elongation: 1-1/8 inches.
 6. Minimum Allowable Offset: 1-1/8 inches.
 7. Minimum Allowable Angular Movement: 20 degrees.
 8. Joint: Steel flanges.

9. Accessories: Galvanized aircraft-type cable or control rods to prevent over extension.
10. Basis of Design: Metraflex Doublesphere.

2.3 SEISMIC RESTRAINT DEVICES

- A. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.
- B. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts and replaceable resilient isolation washers and bushings. Mason Type: Z-1011 or Z-1225. Snubber load rating to match equipment size.
 1. Anchor bolts for attaching to concrete be seismic-rated, drill-in and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.
- C. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement. Mason Type: SCB.
- D. Anchor Bolts: Seismic-rated, drill-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.
- E. Seismic Restraint Systems for Ductwork and Piping: Curb to have anchorage pre-approval "OPA" number from OSHPD in state of California attesting to maximum certified horizontal and vertical load ratings. Brace assemblies and rod clamps have an Anchorage Pre-approval "OPA" Number from OSHPD in State of California verifying maximum certified load ratings. Fire/smoke dampers, fire dampers or any other device with break away connections cannot be used for seismic restraint.

2.4 FACTORY FINISHES

- A. Provide manufacturer's standard prime-coat finish ready for field painting. Units mounted outdoors exposed to weather: Epoxy powder coated, with 1000 hour salt spray rating per ASTM B-117. For high levels of corrosion protection utilize:
 1. Conform to AAMA 605.2.
 2. Apply coating following cleaning and pretreatment.
 3. Cleaning: AA-C12C42R1X.
 4. Dry system before final finish application.
 5. Total Dry Film Thickness: Approximately 1.2 mils, when baked at 450 degrees F for 10 minutes.
- B. Finish:
 1. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment before shipping.
 2. Powder coating on springs and housings.
 3. Hardware be electrogalvanized. Hot-dip galvanize metal components for exterior use.
 4. Baked enamel for metal components on isolators for interior use.
 5. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

2.5 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING AND DUCTWORK

- A. General Requirements for Restraint Components: Rated strengths, features and applications to be as defined in reports by agency acceptable to authorities having jurisdiction.

- B. Structural Safety Factor: Allowable strength in tension, shear and pullout force of components be at least four times maximum seismic forces to which they will be subjected.
- C. Anchor bolts for attaching to concrete to be seismic-rated, drill-in and stud-wedge or female-wedge type.
- D. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
- E. Maximum 1/4-inch air gap and minimum 1/4-inch thick resilient cushion.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Set floor-mounted equipment with steel base rails on 4-inch-high concrete housekeeping pads. Extend pad 6-inches beyond footprint of equipment in each direction.
- B. Provide mounts for equipment installed outdoors for wind loads of 30 lbs. psf applied to any exposed surface of isolated equipment.
- C. Do not install equipment or pipe which makes rigid contact with building slabs, beams, studs, walls, etc.
- D. Anchor baseplate to floor or structure. Provide rubber grommets and washers to isolate bolt from base plate. Under no circumstances is isolation efficiency to be destroyed when bolting isolators to floor.
- E. Building Penetrations: Isolate water piping and ductwork penetrating wall, ceilings, floors or shafts from structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe or duct at equipment room wall.
- F. Provide roof curbs, equipment supports and roof penetrations. Work to maintain roof warranty. Coordinate location, size, structural connections/requirements and flashing prior to installation.
- G. Install Type 6 horizontal thrust restraints at centerline of thrust, symmetrical on either side of equipment.
- H. Vibration isolators must not cause change of position of equipment or piping which would stress piping connections or misalignment shafts or bearings. Isolated equipment is to be level and in proper alignment with connecting ducts and pipes.
- I. Pipe Hangers in Equipment Rooms: Support water and gas piping connected to rotating equipment within equipment rooms on spring and neoprene hangers. The first three hangers from a piece of vibrating equipment are to have a minimum of 1/2 static deflection of equipment isolators. Other isolators should have a minimum of 1/4 static deflection of equipment isolators.
- J. Examination:
 1. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances and other conditions affecting performance.
 2. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.
- K. Testing: Perform following field quality-control testing:
 1. Isolator seismic-restraint clearance.
 2. Isolator deflection.
 3. Snubber minimum clearances.

- L. Adjusting:
 1. Adjust snubbers according to manufacturer's written recommendations.
 2. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.
- M. Cleaning: After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt and debris.
- N. Demonstration: Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain air-mounting systems. Reference Division 01, General Requirements.

3.2 VIBRATION ISOLATION

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.
- C. Vibration isolators must be installed in strict accordance with manufacturer's written instructions and certified submittal data.
- D. Install isolation as indicated on drawings by type and location and where indicated below.
- E. Equipment Vibration Isolation Schedule:

Equipment	Size	Vibration Isolator Type	Minimum Deflection (in)
Fan-coils, Unit Heaters, Fan-Powered Terminal Units	All	Type 5B, or 5C, FC-1,2	0.75
Condensing Units	0 to 4.5 tons	Type 1 or 2	0.2
Rooftop Air Handlers, AC, Heat Pump Units	0 to 19.5 tons	RC-1, FC-1,2	0.75
Axial, Cabinet, Centrifugal Inline Fans	0 to 23.5-inch diameter	Type 3, 4A, 4B, 5B, or 5C, FC-1	0.75
Propeller Fans	All	Type 2 or Type 5A, FC-1	0.25

- F. Isolation Mounts:
 1. Install minimum of four seismic snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 2. Install resilient bolt isolation washers on equipment anchor bolts.
 3. Provide flexible piping connection and flexible ductwork connection to equipment with isolation mounts or bases.
- G. Isolating Hangers:
 1. Support piping and ductwork connected to isolated equipment within equipment rooms on isolating hangers as scheduled on drawings. Unless otherwise noted, first three hangers from isolated equipment to have a minimum of 1/2 static deflection of equipment isolators. Other isolating hangers to have a minimum of 1/4 static deflection of equipment isolators.
 2. Position isolating hanger elements as high as possible in hanger rod assembly, but not in contact with building structure. Install hangers so that hanger housing may rotate full 360 degrees about rod axis without contacting any object.
 3. Unless otherwise noted, air supply units with internally isolated fans do not require isolating hangers for connecting pipes and ductwork.

4. Where parallel running pipes are hung together on an isolated trapeze, provide isolator deflections for largest determined by provisions for pipe isolation. Do not mix isolated and non-isolated pipes in same trapeze.
 5. Install limit stops so they are out of contact during normal operation.
- H. Adjusting:
1. Adjust isolators after piping systems have been filled and equipment is at operating weight.
 2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
 3. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

3.3 SEISMIC RESTRAINT DEVICES

- A. Reference 3.01, General Installation Requirements.
- B. Install in strict accordance with manufacturer's written instructions and certified submittal data.
- C. Install and adjust seismic restraints so equipment, piping and ductwork supports are not degraded by restraints.
- D. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.
- E. Install restraining cables at each trapeze, individual pipe hanger and hanging vibration isolated equipment. Provide restraining cables in each of the four directions of movement. Install restraining cables no less than 45 Degrees from vertical. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.
- F. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

3.4 FACTORY FINISHES

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.
- C. Finishes to be factory-applied. No field patching or holidays allowed.

3.5 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING AND DUCTWORK

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.
- C. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

SECTION 230553
IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Plastic Nameplates
 - 2. Tags
 - 3. Plastic Pipe Markers
 - 4. Ceiling Tags

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Schedules:
 - a. Submit valve schedule for each piping system, in tabular format using Microsoft Word or Excel software. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
 - 2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC Sections. Where more than a single type is specified for application, provide single selection for each product category.
- B. Plastic Nameplates:
 - 1. Brady Corporation
 - 2. Brimar
 - 3. Champion America
 - 4. Craftmark
 - 5. Seton
 - 6. Or approved equivalent.
- C. Tags:
 - 1. Brady Corporation
 - 2. Brimar
 - 3. Champion America
 - 4. Craftmark
 - 5. Seton
 - 6. Or approved equivalent.
- D. Plastic Pipe Markers:
 - 1. Brady Corporation
 - 2. Brimar
 - 3. Champion America
 - 4. Craftmark
 - 5. Seton
 - 6. Or approved equivalent.
- E. Ceiling Tags:
 - 1. Brady Corporation
 - 2. Brimar
 - 3. Champion America
 - 4. Craftmark
 - 5. Seton
 - 6. Or approved equivalent.

2.2 PLASTIC NAMEPLATES

- A. Description: Engraving stock melamine plastic laminate in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide 1/8-inch thick material.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2-inch.
 - 3. Background Color: Black.
 - 4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.

2.3 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 2-inch diameter.
- B. Metal Tags: Polished Brass with stamped letters; tag size minimum 2-inch diameter with smooth edges.
- C. Valve designations to be coordinated with existing valve identifications to ensure no repetitive designations are utilized.
- D. Chart/Schedules: Valve Schedule Frames. For each page of a valve schedule, provide glazed display frame with removable mounting as appropriate for wall construction upon which frame is to be mounted. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.
- E. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.
- F. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 1. Size: Approximately 4 by 7-inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 4. Color: Yellow background with black lettering.

2.4 PLASTIC PIPE MARKERS

- A. Color: Conform to ASME A13.1 and ANSI Z535.1.
- B. Plastic Pipe Markers (for external diameters of 6-inches and larger including insulation): Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers (for external diameters less than 6-inches including insulation): Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Lettering:
 1. 3/4-inch to 1-1/4-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 1/2-inch high letters.
 2. 1-1/2-inch to 2-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 3/4-inch high letters.
 3. 2-1/2-inch to 6-inch Outside Diameter of Insulation or Pipe: 12-inch long color field, 1-1/4-inch high letters.
 4. 8-inch to 10-inch Outside Diameter of Insulation or Pipe: 24-inch long color field, 2-1/2-inch high letters.
 5. Over 10-inch Outside Diameter of Insulation or Pipe: 32-inch long color field, 3-1/2-inch high letters.

2.5 CEILING TAGS

- A. Description: Steel with 3/4-inch diameter color coded head.
- B. Color code as follows:

1. Yellow - HVAC equipment.
2. Red - Fire dampers/smoke dampers.
3. Blue - Heating/cooling valves.
4. Ceiling tile labels, machine generated, adhesive backed tape labels with black letters, clear tape.

PART 3 - EXECUTION

3.1 GENERAL - INSTALLATION

- A. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body.
- B. Identify ductwork with plastic ductmarkers.
- C. Identify piping, concealed or exposed, with plastic pipe markers.
- D. Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- E. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).
- F. Degrease and clean surfaces to receive adhesive for identification materials.
- G. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- H. Coordinate with the facility maintenance personnel to insure consistency with the existing tagging system.
- I. Install all products in accordance with manufacturer's instructions.
- J. Manual Balancing Dampers: Provide 12-inch long orange marker ribbon to end of balancing damper handle.

3.2 PLASTIC NAMEPLATES

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners.
- B. Identify control panels and major control components outside panels with plastic nameplates riveted to equipment body.
- C. Identify thermostats with nameplates.

3.3 TAGS

- A. Use metal tags on piping 3/4-inch diameter and smaller.
- B. Tag balancing valves and major dampers with balanced GPM or CFM indicated after balancing is completed and accepted.
- C. Install tags with corrosion resistant chain.
- D. Small devices, such as in-line pumps, may be identified with tags.

- E. Identify valves in main and branch piping with metal tags. Indicate valve function and the normally open or closed positions on the valve tag.
- F. Identify air terminal units and radiator valves with numbered plastic tags.
- G. Tag automatic controls, instruments, and relays. Key to control schematic.
- H. Install valve schedule at each mechanical room.

3.4 PLASTIC PIPE MARKERS

- A. Install plastic pipe markers complete around pipe in accordance with manufacturer's instructions.
- B. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20-feet (reduced to 10-feet in congested areas and mechanical equipment rooms) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction. Locate near branches, valves, control devices, equipment connections, access doors, floor/wall penetrations.

3.5 CEILING TAGS

- A. Provide ceiling tile labels to identify valves, dampers, and equipment above accessible ceilings.
- B. Provide ceiling tags to locate valves, dampers, and equipment above accessible ceilings. Locate in corner of ceiling tee grid closest to equipment.

END OF SECTION

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. General Requirements and Procedures
 - 2. Fundamental Air Systems Balancing Procedures
 - 3. Temperature Control Verification
 - 4. Constant Volume Air Systems Balancing Procedures
 - 5. Pre-Balance Reporting
 - 6. Final Reports:
 - a. Report Requirements
 - b. General Report Data
 - c. System Diagrams
 - d. Air Handling Units
 - e. Fans
 - f. Duct Traverses
 - g. Diffusers/Registers/Grilles
 - h. Instrument Calibration
 - 7. Additional Tests

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Quality-Assurance Submittals: Submit two copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
 - 2. Pre-Construction Phase Report:
 - a. Provide a pre-construction phase TAB Plan at least two weeks prior to the commencement of TAB work. This report is to include:
 - 1) A complete set of report forms intended for use on the project, with all data filled in except for the field readings. Forms to be project specific.
 - 2) Marked up shop drawings identifying all HVAC equipment to be balanced, and associated outlets and terminal devices.
 - 3) Identification of the type, manufacturer, and model of the actual instruments to be used, and clear indication of which instrument will be used to take each type of reading. Calibration certifications are to be included.
 - 4) A narrative of any project specific and/or non-standard TAB procedures to be used, and the equipment or systems they apply to.

3. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit two copies of the Contract Documents review report as specified in Part 3 of this Section.
4. Strategies and Procedures Plan: Submit two copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 below. Include a complete set of report forms intended for use on this Project.
5. Specify reports required because of editing procedures in Part 3 of this Section.
6. Certified Testing, Adjusting, and Balancing Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
7. Sample Report Forms: Submit two sets of sample testing, adjusting, and balancing report forms.
8. Test Instrument Calibration: Submit proof of calibration within the last 6 months.
9. Final Report.
10. Provide additional submittals to commissioning authority as dictated in commissioning specifications.

1.5 QUALITY ASSURANCE

- A. Quality Assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 1. Acceptable Balance Firm:
 - a. General:
 - 1) Procure services of independent balance and testing agency which specializes in balancing and testing of plumbing, heating, ventilating, and air conditioning systems, to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems. Minimum Experience: 5 years.
 - b. Industry Standards: Testing and Balancing will conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
 - 1) NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
 - 2) ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
 - 3) ANSI:
 - (a) S1.4 Specifications for sound level meters.
 - (b) S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.
 - (c) ANSI S1.13 Methods for the Measurement of Sound Pressure Levels.
 - c. Test Observation: If requested, conduct tests in the presence of the Architect or the Architect's representative.
 2. Noise Criteria:
 - a. Noise levels in all 8 octave bands due to equipment and duct systems not-to-exceed the following NC levels:

TYPE OF ROOM	NC LEVEL
Bathrooms and Toilet Rooms	35-40
Corridors (Public)	35-40
Offices, Small Private (2 or fewer occupants)	30-35
Kitchens	40-45
Cafeteria/Dining	35-40
All Others	35-40

- b. For equipment which has no sound power ratings scheduled on the Drawings, select equipment that the foregoing noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure in accordance with ASHRAE Fundamentals Handbook, Chapter 7, Sound and Vibration.
 - c. An allowance, not-to-exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
 - d. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.
3. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not-to-exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.
 4. Provide proof of testing agency having successfully completed at least five projects of similar size and scope.
 5. Code Compliance: Perform tests in the presence of the Authority Having Jurisdiction (AHJ) where required by the Authority Having Jurisdiction (AHJ).
 6. Owner Witness: Perform tests in the presence of the Owners representative.
 7. Engineer Witness: The engineer or engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.
 8. Simultaneous Testing: Test observations by the Authority Having Jurisdiction (AHJ), the Owner's representative and the engineer's representative need not occur simultaneously.
 9. Do not perform testing, adjusting, and balancing work until heating, ventilating, and air conditioning equipment has been completely installed and is operating continuously as required.
 10. Conduct air testing and balancing with clean filters in place. Clean strainers prior to performing hydronic testing and balancing.
 11. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by AABC or NEBB.
 12. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location.
 - a. Agenda Items: Include at least the following:
 - 1) Submittal distribution requirements.
 - 2) Contract Documents examination report.
 - 3) Testing, adjusting, and balancing plan.
 - 4) Work schedule and Project site access requirements.
 - 5) Coordination and cooperation of trades and subcontractors.
 - 6) Coordination of documentation and communication flow.
 13. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 - a. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
 - b. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
 14. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."

15. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
16. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.
17. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
18. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 1. TAB Agency provides warranty for a period of 90 days following submission of completed report, during which time, Owner may request a recheck of up to 10 percent of total number of terminals, or resetting of any outlet, coil, or device listed in the final TAB report.
 2. Guarantee: Meet the requirements of the following programs:
 - a. Provide a guarantee on AABC or NEBB forms stating that the agency will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1) The certified Agent has tested and balanced systems according to the Contract Documents.
 - 2) Systems are balanced to optimum performance capabilities within design and installation limits.

1.7 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a persons skin than is normally dissipated.
- D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- E. Report Forms: Test data sheets for recording test data in logical order.
- F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- J. TAB: Testing and Balancing.

- K. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- L. Test: A procedure to determine quantitative performance of a system or equipment.
- M. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- N. AABC: Associated Air Balance Council.
- O. AMCA: Air Movement and Control Association.
- P. CTI: Cooling Tower Institute.
- Q. NEBB: National Environmental Balancing Bureau.
- R. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.8 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
- B. Notice: Provide 7 days advance notice for each test. Include scheduled test dates and times.
- C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS AND PROCEDURES

- A. Project Conditions:
 1. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.
 2. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.
 3. Non-Owner Occupancy: Complete balancing of building systems prior to Substantial Completion and owner occupancy.
- B. General Requirements:
 1. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and controls, coordinate scheduling and testing and inspection procedures with authorities having jurisdiction.
 2. Perform TAB work with doors, closed windows, and ceilings installed etc., to obtain simulated or project operating conditions. Do not proceed until systems scheduled for testing, adjusting and balancing are clean and free from debris, dirt and discarded building materials.
 3. Where Owner occupies building during the testing period, cooperate with Owner to minimize conflicts with Owner's operations.
- C. Examination:

1. Examine Contract Documents to become familiar with project requirements and existing building record documents (if available) to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 - a. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 - b. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 2. Examine approved submittal data of HVAC systems and equipment.
 3. Examine project record documents described in Division 01, General Requirements.
 4. Examine Architect's and Engineer's design data, including Basis of Design, HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
 5. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
 6. Coordinate requirements in system and equipment with this Section.
 7. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
 8. Examine system and equipment test reports.
 9. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 10. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
 11. Examine equipment for installation and for properly operating safety interlocks and controls.
 12. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.
 13. Beginning of work means acceptance of existing conditions.
- D. Preparation:
1. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
 2. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - a. Permanent electrical power wiring is complete.
 - b. Hydronic systems are filled, clean, and free of air.
 - c. Automatic temperature-control systems are operational.
 - d. Equipment and duct access doors are securely closed.
 - e. Balance, smoke, and fire dampers are open.
 - f. Isolating and balancing valves are open and control valves are operational.
 - g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - h. Windows, doors and other portions of the building envelope can be closed so design conditions for system operations can be met.
 3. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - a. Attendance is required by installers whose work will be tested, adjusted, or balanced.

4. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- E. General Testing and Balancing Procedures:
1. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
 2. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
 3. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- F. Adjustment Tolerances:
1. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
 2. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
 3. Adjust supply, return, and exhaust air quantities to maintain pressurization in spaces indicated on Drawings. Note and document room-to-room pressurization and maintain these relationships. Adjust pressure controlled spaces to within plus or minus 0.01 in WC.
- G. Recording and Adjusting:
1. Field Logs: Maintain written logs including:
 - a. Running log of events and issues.
 - b. Discrepancies, deficient or uncompleted work by others.
 - c. Contract interpretation requests.
 - d. Lists of completed tests.
 2. Ensure recorded data represents actual measured or observed conditions.
 3. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
 4. Mark on drawings locations where traverse and other critical measurements were taken and cross reference location in final report.
 5. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
 6. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
 7. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner's Representative, or Commissioning Agent.

3.2 FUNDAMENTAL AIR SYSTEMS BALANCING PROCEDURES

- A. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- B. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.
- C. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- D. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

- E. Prepare test reports for both fans and inlets and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan volumes.
- F. Prepare schematic diagrams of systems' "as-built" duct layouts.
- G. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- H. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- I. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- J. Verify that motor starters are equipped with thermal protection, sized for the connected load.
- K. Check dampers for proper position to achieve desired airflow path.
- L. Check for airflow blockages.
- M. Check that condensate drains are installed, trapped and primed and routed to drain.
- N. Check for readily observable leaks in air-handling unit components and ductwork.
- O. Use sheaves and pulleys to adjust the speed of belt drive fans to achieve design flow with motors running at 60 Hertz unless noted otherwise.

3.3 TEMPERATURE CONTROL VERIFICATION

- A. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices operate by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, equipment, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to design values.
- B. Verify that controllers are calibrated and commissioned.
- C. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- D. Record controller settings and note variances between set points and actual measurements.
- E. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
- F. Verify free travel and proper operation of control devices such as damper and valve operators.
- G. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
- H. Confirm interaction of electrically operated switch transducers.

- I. Confirm interaction of interlock and lockout systems.
- J. Verify main control supply-air pressure and observe compressor and dryer operations.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.4 CONSTANT-VOLUME AIR SYSTEMS BALANCING PROCEDURES

- A. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer. Adjust fans to deliver design airflow at the lowest possible speed.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each air-handling unit component under final balanced condition.
 - 3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Recommend corrective action to align design and actual conditions.
 - 4. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - 5. Do not make fan-speed adjustments that result in motor loading greater than full load amps. Do not increase fan speed beyond fan class rating. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
 - 6. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
 - 7. Calibrate airflow measuring stations.

3.5 PRE-BALANCE REPORTING

- A. Pre-Construction Phase Report:
 - 1. Provide a pre-construction phase TAB Plan at least 2 weeks prior to the commencement of TAB work. This report is to include:
 - a. A complete set of report forms intended for use on the project, with all data filled in except for the field readings. Forms to be project specific.
 - b. Marked up shop drawings identifying all HVAC equipment to be balanced, and associated outlets and terminal devices.
 - c. Identification of the type, manufacturer, and model of actual instruments to be used, and clear indication of which instrument will be used to take each type of reading. Calibration certifications are to be included.
 - d. A narrative of any project specific and/or non-standard TAB procedures to be used, and the equipment or systems they apply to.
- B. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- C. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced.

3.6 FINAL REPORTS

A. Report Requirements:

1. General:

- a. Computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into Sections by tested and balanced systems.
- b. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1) Include a list of the instruments used for procedures, along with proof of calibration.
- c. Final Report Contents: In addition to the certified field report data, include the following:
 - 1) Pump curves.
 - 2) Fan Curves
 - 3) Manufacturers Test Data
 - 4) Field test reports prepared by system and equipment installers.
 - 5) Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

B. General Report Data:

1. In addition to the form titles and entries, include the following data in the final report, as applicable:
 - a. Title Page
 - b. Name and Address of Testing, Adjusting, and Balancing Agent
 - c. Project Name
 - d. Project Location
 - e. Architect's Name and Address
 - f. Engineer's Name and Address
 - g. Contractor's Name and Address
 - h. Report Date
 - i. Signature of Testing, Adjusting, and Balancing Agent who Certifies the Report
 - j. Summary of Contents, Including the Following:
 - 1) Design versus Final Performance
 - 2) Notable Characteristics of Systems
 - 3) Description of System Operation Sequence if it varies from the Contract Documents
 - k. Nomenclature Sheets for Each Item of Equipment
 - l. Data for Terminal Units, including Manufacturer, Type Size, and Fittings
 - m. Notes to explain why certain final data in the body of reports vary from design values.
 - n. Test Conditions for Fans and Pump Performance Forms, Including the Following:
 - 1) Settings for Outside-, Return-, and Exhaust-air Dampers
 - 2) Conditions of Filters
 - 3) Cooling Coil, Wet- and Dry-bulb Conditions
 - 4) Face and Bypass Damper Settings at Coils
 - 5) Fan Drive Settings, including Settings and Percentage of Maximum Pitch Diameter
 - 6) Inlet Vane Settings for Variable-Air-Volume Systems
 - 7) Settings for Supply-air, Static-pressure Controller
 - 8) Other System Operating Conditions that affect Performance

C. System Diagrams:

1. Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
 - a. Quantities of Outside, Supply, Return, and Exhaust Airflows
 - b. Water and Steam Flow Rates
 - c. Duct, Outlet, and Inlet Sizes
 - d. Pipe and Valve Sizes and Locations
 - e. Terminal Units
 - f. Balancing Stations

D. Air Handling Units:

1. For air-handling units, packaged rooftop unit air handlers, split systems, fan coils, heat pumps, and evaporator units with coils, include the following:

- a. Unit Data: Include the following:
 - 1) Unit Identification
 - 2) Location
 - 3) Make and Type
 - 4) Model Number and Unit Size
 - 5) Manufacturer's Serial Number
 - 6) Unit Arrangement and Class
 - 7) Discharge Arrangement
 - 8) Sheave Make, Size in inches, and Bore
 - 9) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
 - 10) Number of Belts, Make, and Size
 - 11) Number of Filters, Type, and Size
- b. Motor Data: Include the following:
 - 1) Make and Frame Type and Size
 - 2) Horsepower and rpm
 - 3) Volts, Phase, and Hertz
 - 4) Full-load Amperage and Service Factor
 - 5) Sheave Make, Size in Inches, and Bore
 - 6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
- c. Test Data: Include design and actual values for the following:
 - 1) Total Airflow Rate in cfm (L/s)
 - 2) Total System Static Pressure in Inches wg (Pa)
 - 3) Fan rpm
 - 4) Discharge Static Pressure in Inches wg (Pa)
 - 5) Filter Static-pressure Differential in Inches wg (Pa)
 - 6) Preheat Coil Static-pressure Differential in Inches wg (Pa)
 - 7) Cooling Coil Static-pressure Differential in Inches wg (Pa)
 - 8) Heating Coil Static-pressure Differential in Inches wg (Pa)
 - 9) Outside Airflow in cfm (L/s)
 - 10) Return Airflow in cfm (L/s)
 - 11) Outside-air Damper Position
 - 12) Return-air Damper Position
 - 13) Vortex Damper Position

E. Fans:

1. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - a. Fan Data: Include the following:
 - 1) System Identification
 - 2) Location
 - 3) Make and Type
 - 4) Model Number and Size
 - 5) Manufacturer's Serial Number
 - 6) Arrangement and Class
 - 7) Sheave Make, Size in Inches, and Bore
 - 8) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches.
 - b. Motor Data: Include the following:
 - 1) Make and Frame Type and Size
 - 2) Horsepower and rpm
 - 3) Volts, Phase, and Hertz
 - 4) Full-load Amperage and Service Factor
 - 5) Sheave Make, Size in Inches, and Bore
 - 6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
 - 7) Number of Belts, Make, and Size
 - c. Test Data: Include design and actual values for the following:
 - 1) Total Airflow Rate in cfm
 - 2) Total System Static Pressure in Inches wg
 - 3) Fan rpm
 - 4) Discharge Static Pressure in Inches wg
 - 5) Suction Static Pressure in Inches wg

F. Duct Traverses:

1. Include a diagram with a grid representing the duct cross-Section and record the following:
 - a. Report Data: Include the following:
 - 1) System and Air-handling Unit Number
 - 2) Location and Zone
 - 3) Traverse Air Temperature in Degrees F
 - 4) Duct Static Pressure in Inches wg
 - 5) Duct Size in Inches
 - 6) Duct Area in SF
 - 7) Design Airflow Rate in cfm
 - 8) Design Velocity in fpm
 - 9) Actual Airflow Rate in cfm
 - 10) Actual Average Velocity in fpm
 - 11) Barometric Pressure in PSIG

G. Diffusers/Registers/Grilles:

1. For diffusers, registers and grilles, include the following:
 - a. Unit Data: Include the following:
 - 1) System and Air-handling Unit Identification
 - 2) Location and Zone
 - 3) Test Apparatus Used
 - 4) Area Served
 - 5) Air-terminal-device Make
 - 6) Air-terminal-device Number from System Diagram
 - 7) Air-terminal-device Type and Model Number
 - 8) Air-terminal-device Size
 - 9) Air-terminal-device Effective Area in SF
 - b. Test Data: Include design and actual values for the following:
 - 1) Airflow Rate in cfm
 - 2) Air Velocity in fpm
 - 3) Preliminary Airflow Rate as Needed in cfm
 - 4) Preliminary Velocity as Needed in fpm
 - 5) Final Airflow Rate in cfm
 - 6) Final Velocity in fpm
 - 7) Space Temperature in Degrees F

H. Instrument Calibration:

1. For instrument calibration, include the following:
 - a. Report Data: Include the following:
 - 1) Instrument Type and Make
 - 2) Serial Number
 - 3) Application.
 - 4) Dates of Use
 - b. Dates of Calibration.

3.7 ADDITIONAL TESTS

- A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 230700 HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Type A, Flexible Fiberglass Blanket
 - 2. Type B, Duct Liner
 - 3. Type 1, Fiberglass Pipe Insulation
 - 4. Type 2, Flexible Elastomeric Insulation
 - 5. Jacketing
 - 6. Accessories
 - 7. Duct Insulation Accessories
 - 8. Duct Insulation Compounds
 - 9. Outdoor Ducting Cover

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Installer qualifications.
 - 2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any) for each type of product indicated.
 - 3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
 - 4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
 - 5. Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Installer to have minimum 5 years experience in the business of installing insulation.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1.

1.7 FIRE HAZARD CLASSIFICATION

- A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a flame spread of 25, fuel contributed of 50 and smoke developed of 50 as tested by current edition of ASTM E84 (NFPA 255) method.
- B. Test pipe insulation in accordance with the requirements of current edition of UL "Pipe and Equipment Coverings R5583 400 8.15."
- C. Test duct insulation in accordance with current edition of ASTM E84, UL 723, NFPA 255, NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Type A, Flexible Fiberglass Blanket:
 - 1. Certainteed
 - 2. Johns Manville
 - 3. Knauf
 - 4. Owens-Corning
 - 5. PPG
 - 6. Or approved equivalent.
- B. Type 1, Fiberglass Pipe Insulation:
 - 1. Certainteed
 - 2. Johns Manville
 - 3. Knauf
 - 4. Owens-Corning
 - 5. PPG
 - 6. Or approved equivalent.
- C. Type 2, Flexible Elastomeric Insulation:
 - 1. Glue:
 - a. Armacell LLC Armaflex Low VOC Adhesive
 - b. Halstead
 - c. Or approved equivalent.
 - 2. Paint:
 - a. Armacell LLC Armaflex
 - b. Halstead
 - c. Or approved equivalent.
- D. Jacketing:
 - 1. ITW Insulation Systems
 - 2. Or approved equivalent.
- E. Accessories:
 - 1. ITW Insulation Systems

2. Or approved equivalent.
- F. Duct Insulation Accessories:
1. Certainteed
 2. Johns Manville
 3. Owens-Corning
 4. Or approved equivalent.
- G. Duct Insulation Compounds:
1. Certainteed
 2. Johns Manville
 3. Owens-Corning
 4. Or approved equivalent.
- H. Outdoor Ducting Cover:
1. Certainteed
 2. Johns Manville
 3. Owens-Corning
 4. Or approved equivalent.

2.2 TYPE A, FLEXIBLE FIBERGLASS BLANKET

- A. ASTM C553, Type 1, Class B-2; flexible blanket.
- B. 'K' Value: $0.27 \text{ BTU}\cdot\text{in}/(\text{hr}\cdot\text{sf}\cdot\text{F})$ at 75 degrees F installed, maximum service temperature: 250 degrees F.
- C. Density: 0.75 pounds per cubic foot.
- D. Vapor Barrier Jacket: FSK aluminum foil reinforced with fiberglass yarn and laminated to fire resistant Kraft, secured with UL listed pressure sensitive tape or outward clinched expanded staples and vapor barrier mastic as needed.

2.3 TYPE B, DUCT LINER

- A. ASTM C1071; flexible blanket.
- B. 'K' Value: ASTM C518, $0.25 \text{ BTU}\cdot\text{in}/(\text{hr}\cdot\text{sf}\cdot\text{F})$ at 75 degrees F, maximum service temperature: 250 degrees F.
- C. Noise Reduction Coefficient: 0.65 or higher based on "Type A mounting."
- D. Maximum Velocity on Mat or Coated Air Side: 5,000 FPM.
- E. Adhesive: UL listed waterproof type.
- F. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
- G. Erosion-Resistant Surfaces: UL 181.
- H. ASTM G21 and ASTM G22 Microbial Growth Resistance.

2.4 TYPE 1, FIBERGLASS PIPE INSULATION

- A. Glass Fiber: ASTM C547; rigid molded, noncombustible.
 1. Thermal Conductivity Value: As indicated in the insulation tables below.
 2. Maximum Service Temperature: 850 degrees F.

3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or vapor barrier mastic.

2.5 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

- A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 1. Thermal Conductivity Value: As indicated in the insulation tables below.
 2. Maximum Service Temperature of 220 degrees F.
 3. Maximum Flame Spread: 25.
 4. Maximum Smoke Developed: 50 (1-inch thick and below).
 5. Connection: Waterproof vapor retarder adhesive as needed.
 6. UV Protection: UV outdoor protective coating per manufacturers requirements.
- B. Glue: Contact adhesive specifically manufactured for cementing flexible elastomeric foam. Armacell LLC Armaflex Low VOC adhesive, Halstead, or approved equivalent.
- C. Paint: Nonhardening high elasticity type, specifically manufactured as protective covering of flexible elastomeric foam insulation for prevention of degradation due to exposure to sunlight and weather. Armacell LLC Armaflex, Halstead, or approved equivalent.

2.6 JACKETING

- A. Canvas Jacket: UI listed fabric, 6 ounce/sq. yd., plain weave cotton treated with dilute fire retardant lagging adhesive.
- B. PVC preformed molded insulation covers. Zeston or approved equivalent.
- C. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner.
- D. Stainless Steel Jacket: Type 304 stainless steel, 0.010-inch, smooth finish.

2.7 ACCESSORIES

- A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.
- B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
- C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

2.8 DUCT INSULATION ACCESSORIES

- A. Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

2.9 DUCT INSULATION COMPOUNDS

- A. Cements, adhesives, coatings, sealers, protective finishes and similar accessories as recommended by insulation manufacturer for applications indicated.

2.10 OUTDOOR DUCTING COVER

- A. Aluminum Jacket: 0.016-inch-thick sheet, smooth/embossed finish, with longitudinal slip joints and 2-inch laps.
- B. Nonwater vapor retarder, nonburning, weatherproof coating for use over insulation where "breathing" is required.
- C. UV resistant polyvinyl chloride covering with joints secured and sealed.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Verification of Conditions:
 - 1. Do not apply insulation until pressure testing of the ducts and piping has been completed. Do not apply to pipe with heat tracing until system has been tested. Do not apply insulation until the duct has been inspected.
 - 2. Examine areas and conditions under which duct and pipe insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Preparation:
 - 1. Clean and dry surfaces to be insulated.
- C. Installation:
 - 1. Insulation: Continuous through walls, floors and partitions except where noted otherwise.
 - 2. Piping and Equipment:
 - a. Install insulation over clean, dry surfaces with adjoining Sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
 - b. Cover insulation on pipes above ground, outside of building, with aluminum jacketing. Position seam on bottom of pipe.
- D. Provide accessories as required. See Part 2 Article "Accessories" above.
- E. Protection and Replacement:
 - 1. Installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- F. Fiberglass Insulation:
 - 1. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate the vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.
 - 2. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use performed PVC molded insulation covers.
- G. Labeling and Marking:
 - 1. Provide labels, arrows and color on piping and ductwork. Attach labels and flow direction arrows to the jacketing per Section 23 05 53, Identification for HVAC Piping, Ductwork and Equipment.
- H. Ductwork:

1. Install insulation in conformance with manufacturer's recommendations to completely cover duct.
 2. Butt insulation joints firmly together and install jackets and tapes smoothly and securely.
 3. Apply duct insulation continuously through sleeves and prepared openings, except as otherwise specified. Apply vapor barrier materials to form complete unbroken vapor seal over insulation.
 4. Coat staples and seals with vapor barrier coating.
 5. Cover breaks in jacket materials with patches of same material as vapor barrier. Extend patches not less than 2-inches beyond break or penetration on all directions and secure with adhesive and staples. Seal staples and joints with vapor barrier coating.
 6. Fill jacket penetrations. i.e., hangers, thermometers and damper operating rods, and other voids in insulation with vapor barrier coating. Seal penetration with vapor barrier coating. Insulate Hangers and Supports for cold duct in un-conditioned spaces to extent to prevent condensation on surfaces.
 7. Seal and flash insulation terminations and pin punctures with reinforced vapor barrier coating.
 8. Continue insulation at fire dampers and fire/smoke dampers up to and including those portions of damper frame visible at outside of the rated fire barrier. Insulating terminations at fire dampers in accordance with this Section.
 9. Do not conceal duct access doors with insulation. Install insulation terminations at access door in accordance with this Section.
- I. Insulated Pipe Exposed to Weather:
1. Where piping is exposed to weather, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Install metal jacket with 2-inch overlap at longitudinal and butt joints with exposed lap pointing down. Secure jacket with stainless-steel draw bands 12-inches on center and at butt joints.
- J. Insulation Shields:
1. Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation Section at insulation shields for lines 2-inches and larger for steam and chilled water piping.
- K. Ductwork Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Duct Size	Insulation Thickness
Supply ductwork where duct is not specified to be lined.	A	All	1-1/2-inch
Return ductwork where duct is not specified to be lined or where ductboard is not utilized.	--	All	None
Supply ductwork (exposed to weather, in crawl space and in unheated attics)	A	All	3-inch
Return ductwork (exposed to weather, in crawl space and in unheated attics)	A	All	3-inch
Outside Air Ducts	A	All	3-inch
HVAC plenums and unit housings not preinsulated	B	All	1-1/2-inch

Exhaust ducts within 10-feet of exterior	A	All	3-inch
--	---	-----	--------

- Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.

L. Piping Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Conductivity Range (Btu-inch per hour per SF per degrees F)	Pipe Size (inches)	Insulation Thickness (inches)
Refrigerant Suction Piping (40F to 60F)	2	0.21-0.27 at a mean rating temperature of 75 degrees F	< 1	0.5
			1 to < 1.5	0.5
			1.5 to < 4	1.0
			4 to < 8	1.0
			>= 8	1.0
Refrigerant Suction Piping (<=40F)	2	0.20-0.26 at a mean rating temperature of 50 degrees F	< 1	0.5
			1 to < 1.5	1.0
			1.5 < 4	1.0
			4 to < 8	1.0
			>= 8	1.0

- Note: Insulation thickness shown is a minimum. If state code requires additional thickness, then provide insulation thickness per code requirements.

3.2 TYPE A, FLEXIBLE FIBERGLASS BLANKET

- Install insulation in conformance with manufacturers recommendations and requirements.
- Duct Wrap: Cover air ducts per insulation table except ducts internally lined where internal duct lining is adequate to achieve adequate insulating values to meet local Energy Codes (indicate on shop drawings, locations where duct wrap is planned to be omitted and indicate internal duct lining insulating values to confirm they will meet the Energy Code.) Wrap tightly with circumferential joints butted and longitudinal joints overlapped minimum of 2-inches. Adhere insulation with 4-inch strips of insulating bending adhesive at 8-inches on center. On ducts over 24-inches wide, additionally secure insulation with suitable mechanical fasteners at 18-inches on center. Circumferential and longitudinal joints stapled with flare staples 6-inches on center and covered with 3-inch wide, foil reinforced tape.

3.3 TYPE B, DUCT LINER

- Install insulation in conformance with manufacturers recommendations and requirements.
- Duct Liners: Mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous (minimum 90) percent coat of adhesive. For widths over 20-inches, additionally secure liner with mechanical fasteners 15-inches on center or per manufacturer requirements. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom Sections of insulation overlap sides. Factory/field coat exposed edges. Metal nosing for exposed leading edges and when velocity exceeds 3500 FPM or manufacturer rating on exposed edges.

Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty. Cut studs off near washers. Do not use small pieces. If insulation is installed without horizontal, longitudinal, and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.

3.4 TYPE 1, FIBERGLASS PIPE INSULATION

- A. Install insulation in conformance with manufacturers recommendations and requirements.
- B. See General Installation Requirements above.
- C. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.
- D. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.
- E. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation Section at insulation shields for lines 2-inches and larger (hot and cold piping).

3.5 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

- A. Flexible Elastomeric Insulation:
 - 1. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and undergrade with two coats of finish as recommended by manufacturer.
- B. Flexible Elastomeric Tubing:
 - 1. Flexible Elastomeric Tubing: Slip insulation over piping or, if piping is already installed, slit insulation and snap over piping. Joints and butt ends must be adhered with 520 adhesive.
- C. Install insulation in conformance with manufacturers recommendations and requirements.
- D. See General Installation Requirements above.
- E. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and undergrade with two coats of finish as recommended by manufacturer.
- F. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation Section at insulation shields for lines 2-inches and larger (hot and cold piping).
- G. Install in accordance with manufacturer's instructions for below grade installation.

3.6 JACKETING

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturers instructions.

3.7 ACCESSORIES

- A. Install insulation in conformance with manufacturers instructions, recommendations and requirements.
- B. See General Installation Requirements above.

- C. Provide and install accessories for all insulation types listed in this Section.

3.8 DUCT INSULATION ACCESSORIES

- A. Install insulation in conformance with manufacturers recommendations and requirements.

3.9 DUCT INSULATION COMPOUNDS

- A. Install insulation in conformance with manufacturers recommendations and requirements.

3.10 OUTDOOR DUCTING COVER

- A. Install insulation in conformance with manufacturers recommendations and requirements.
- B. Outdoor Duct Exposed to Weather:
 1. Install jacket with brakes/slope to prevent standing water on duct.
 2. Weatherproof seal at joints and seams. Minimum 2-inch overlap.
 3. Label jacket every 6-feet and within 2-feet of building penetrations and equipment connections:
"Do not stand or place equipment on duct."

END OF SECTION



SECTION 230933 ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
1. Room Thermostats
 2. Smoke Detection for Projects with a Building Fire Alarm System
 3. Relays and Contactors
 4. Transformers
 5. Wiring
 6. Damper Operators
 7. Carbon Dioxide Sensor 

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
1. Power wiring per Division 26, Electrical.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
1. Drawings: complete control diagram, including written description of control sequences.
 2. Operation and Maintenance Manual: Include record wiring drawings showing installed condition and operating changes made during start-up.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as outlined in Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
1. Within 30 days prior to warranty expiration date, control supplier to visit job site and check calibration, operation, and adjustment of temperature, pressure and humidity sensors, valves, dampers, thermostats and other devices installed by control supplier. Make repair or replacement of defective control equipment as required at no charge to Owner.
 2. Submit letter to Architect certifying that this work has been completed.
 3. Attach copy of service report signed by Owner's Representative.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Room Thermostats:
 - 1. Trane 
 - 2. Honeywell
 - 3. Siemens
 - 4. Johnson Controls
 - 5. Reliable Controls
 - 6. Alerton
 - 7. Or approved equivalent.
- B. Duct/Spot-Type Smoke Detectors (Project with Fire Alarm System):
 - 1. See Division 28 for Products.
- C. Damper Operators:
 - 1. Belimo
 - 2. Honeywell
 - 3. Siemens
 - 4. Or approved equivalent.

2.2 ROOM THERMOSTATS

- A. Electronic Thermostat:
 - 1. Seven day programmable, PI control.
 - 2. Occupied/unoccupied heat and cool setpoints.
 - 3. Automatic heat/cool changeover and fan control.
 - 4. Touch screen display.
 - 5. Cooling Stages: Provide as required to match in air conditioner.
 - 6. Basis of Design: HPelican TS200.

2.3 SMOKE DETECTION (FOR PROJECTS WITH A FIRE ALARM SYSTEM)

- A. See Division 28 for Products.

2.4 RELAYS AND CONTACTORS

- A. Provide relays and contactors where required or as shown on Drawing to meet operating sequence where not internal to manufacturer's equipment.
- B. Furnish relays or contactors with required coil voltage and contact amperage rating for use specified on Drawing and in manufacturer's equipment.
- C. Mount relays in single control cabinet with hinge door and latch.
- D. Control cabinet contains relays and numbered terminal strips for connection of relays and field wiring. Mount cabinet on painted plywood panel securely attached to wall framing. Mount time clock, transformer and motor contactors (if required) on plywood adjacent to control panel.

2.5 TRANSFORMERS

- A. Transformers selected and sized for appropriate VAC capacity and installed and fused according to applicable codes. Provide wiring to nearest suitable power source as required.


2.6 WIRING

- A. In accordance with Division 26, Electrical and applicable codes.
- B. Provide line and low voltage wiring relating to control system. Includes wiring of contactors, relays, circuits, and incidental power wiring: operation power for time clock, power when run through stat/timeclock/relay, transformers.

2.7 DAMPER OPERATORS




- A. Size operators to operate dampers properly against system pressures, pressure differentials and velocities. Damper operators sized for 150 percent of damper forces normally encountered. Spring return closed for outside air applications.

2.8 CARBON DIOXIDE SENSOR

- A. Range and Accuracy: 0 to 2,000 PPM plus or minus 50 PPM. Maximum drift of plus or minus 50 PPM per year. 

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATION

- A. AC Units: Room thermostats to modulate zone damper economizer cycle, cooling and heating in sequence to maintain setpoint. Provide motorized low leakage outside air dampers. Dampers to be closed on fan shutdown and during NLL operation. Program thermostats to time schedule coordinated with Owner. See below for fire shut-down.
- B. Night Low Limit: Provide night low limit thermostat to bypass system clock to maintain night setting of 60 degrees F.
- C. Bypass Timer: To override system and ventilation clocks, one timer for each AC unit.
- D. Central timeclock: Program equipment to start/stop at times determined with Owner; set times and demonstrate to Owner during programming. Set timeclock to start/stop the following equipment:
 - 1. CU-1, CU-2, CU-3, ~~CU-4~~ 
 - 2. FU-1, FU-2, F-1 
 - 3. FCU-1, FCU-2, ~~FCU-3~~ 
- E. Exhaust Fans:
 - 1. Exhaust Fans: Controlled from wall switch. Provide delay-off relay and set to turn fan off 5-minutes after switch is turned off.
- F. Make-up Air Unit: Interlock with existing kitchen exhaust fan.

3.2 SMOKE DETECTION (FOR PROJECTS WITH A FIRE ALARM SYSTEM)

- A. Smoke detector furnished and powered/wired under Division 28, Electronic Safety and Security. Coordinate with fire alarm equipment supplier. Installation of duct smoke detector housing and sampling tube under Division 23, HVAC.
- B. Install smoke detectors in supply air systems greater than 2000 CFM.

3.3 MOTOR RUN STATUS SWITCH

- A. Current Sensing Switches:
 - 1. Route conductors through window of device as recommended by manufacturer.

2. Where equipment load is greater than amp rating of current transformer of current sensing switch, provide 5-amp secondary rated current transformer to monitor load, routing secondary wires through current transformer of current sensing switch. Manufacturers: Veris Industries H6800 series.
3. Coordinate location of switch with Division 26, Electrical for switching of power to fire/smoke dampers.

3.4 INSTALLATION OF AUXILIARY CONTROL DEVICES

A. General:

1. Install sensors and thermostats in accordance with manufacturer's recommendations.
2. Room sensors and thermostats installed at 48-inches AFF to midline of sensor on concealed junction boxes properly supported by wall framing at the locations shown on the Drawings.

B. Actuators:

1. General:

- a. Mount and link control damper actuators according to manufacturer's instructions.
- b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

2. Actuator Mounting for Damper and Valve arrangements to comply to the following:

- a. Damper Actuators: Do not install in the air stream
- b. Use a weather proof enclosure (clear and see through) if actuators are located outside.
- c. Damper or valve actuator ambient temperature not-to-exceed 122 degrees F through any combination of medium temperature or surrounding air. Provide appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation as necessary. Mount per manufacturer's recommendations.
- d. Actuator cords or conduit to incorporate a drip leg if condensation is possible. Do not allow water to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point to be avoided to prevent water from condensing in conduit and running into actuator.

- #### C. Air Flow Station:
- Install where indicated in ductwork with manufacturer's recommended straight ductwork upstream and downstream of air flow station or as shown on drawings, whichever is greater.

END OF SECTION

SECTION 232113 HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Equipment Drains and Overflows
 - 2. Unions
 - 3. Refrigerant Piping

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Installer Qualifications: Company specializing in performing work of the type specified in this Section.
 - 2. Welder Qualifications: Certify in accordance with ASME (BPV IX).
 - 3. ASME Compliance: Comply with ASME B31.9 "Building Services Piping" for materials, products, and installation. Provide safety valves and pressure vessels with the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 01.
 - 4. Refrigerant Piping:
 - a. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX "Welding and Brazing Qualifications."
 - b. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
 - c. ASME Standard: comply with ASME B31.5, "Refrigeration Piping."
 - d. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical" or UL 429 "Electrically Operated Valves."

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements, General Requirements.

B. In addition, provide:

1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As specified in Articles below.

B. Or approved equivalent.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), drawn.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.

2. Joints: Solder, lead free, ASTM B 32, HB alloy (95-5 tin-antimony), or tin and silver.

2.3 UNIONS

A. Unions for Pipe 2-inches and Under:

1. Ferrous Piping: 150, 250, and 300 PSIG malleable iron, threaded, ASME B16.39.

2. Copper Pipe: Bronze, soldered joints, ASME B16.22.

B. Dielectric Connections: Provide dielectric waterway or brass nipple fitting with threaded ends. Dielectric unions are not allowed.

2.4 REFRIGERANT PIPING

A. Piping:

1. Copper Tube: ASTM B 280, Type ACR, drawn-temper tube, clean, dry and capped.

a. Fittings: ASME B16.22 wrought copper.

b. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy (15 percent Silver).

2. Copper Tube to 5/8-inch OD: ASTM B280. Tube ACR, annealed-temper copper tube, clean, dry and capped.

a. Fittings: ASME B16.26 cast copper.

b. Joints: Flared.

B. Moisture and Liquid Indicators:

1. Manufacturers:

a. Henry Technologies.

b. Parker Hannifin/Refrigeration and Air Conditioning.

c. Sporlan Valve Company.

d. Substitutions: See Section 23 00 00, HVAC Basic Requirements, Division 00, Procurement and Contracting Requirements and Division 01, General Requirements requirements.

2. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 300 PSI.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install per manufacturer's written instructions and requirements.

B. See articles below for specific requirements.

3.2 EQUIPMENT DRAINS AND OVERFLOWS INSTALLATION

- A. Install per manufacturer's written instructions and requirements.
- B. See articles below for specific requirements.
- C. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- D. Remove scale and dirt on inside and outside before assembly.
- E. Prepare piping connections to equipment with flanges or unions.
- F. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- G. Install heating water, glycol, condenser water, piping to ASME B31.9 requirements.
- H. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- I. Install piping to conserve building space and to avoid interference with use of space.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Sleeve pipe passing through partitions, walls and floors allowing adequate space for pipe insulation.
- L. Slope piping at 0.2 percent upward in direction of flow and arrange to drain at low points.
- M. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- N. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- O. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- P. Anchor piping for proper direction of expansion and contraction.
- Q. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- R. Pipe Hangers and Supports:
 - 1. Install in accordance with Division 23, HVAC, Hangers and Supports.
 - 2. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 - 3. Place hangers within 12-inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2-inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 6. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
 - 7. Provide copper plated hangers and supports for copper piping.

8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- S. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- T. Provide access where valves and fittings are not exposed.
- U. Use eccentric reducers to maintain top of pipe level.
- V. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- W. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- X. Refrigerant Piping:
 1. Install systems in accordance with ASHRAE Standard 15.
 2. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
 3. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
 4. Flood piping system with nitrogen when brazing.
 5. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
 6. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
 7. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
 8. Fully charge completed system with refrigerant after testing.
- Y. Leave joints, including welds, uninsulated and exposed for examination during test.
- Z. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
- AA. Flush system with clean water. Clean strainers.
- AB. Isolate equipment from piping. If a valve is used to isolate equipment, provide closure capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- AC. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- AD. Perform the following tests on hydronic piping:
 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
 3. Check expansion tanks to determine that they are not air bound and that system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure not-to-exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least four hours, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.

AE. Refrigerant Piping:

1. Test refrigeration system in accordance with ASME B31.5.
2. Pressure test system with dry nitrogen to 200 PSI. Perform final tests at 27-inches vacuum and 200 PSI using electronic leak detector. Test to no leakage.

3.3 UNIONS INSTALLATION

- A. Install per manufacturer's written instructions and requirements.
- B. See articles below for specific requirements.
- C. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- D. Remove scale and dirt on inside and outside before assembly.
- E. Prepare piping connections to equipment with flanges or unions.
- F. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- G. Install heating water, glycol, condenser water, piping to ASME B31.9 requirements.
- H. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- I. Install piping to conserve building space and to avoid interference with use of space.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Sleeve pipe passing through partitions, walls and floors allowing adequate space for pipe insulation.
- L. Slope piping at 0.2 percent upward in direction of flow and arrange to drain at low points.
- M. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- N. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- O. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- P. Anchor piping for proper direction of expansion and contraction.
- Q. Inserts:
 1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- R. Pipe Hangers and Supports:
 1. Install in accordance with Division 23, HVAC, Hangers and Supports.
 2. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 3. Place hangers within 12-inches of each horizontal elbow.
 4. Use hangers with 1-1/2-inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 7. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
 8. Provide copper plated hangers and supports for copper piping.
 9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- S. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- T. Provide access where valves and fittings are not exposed.
- U. Use eccentric reducers to maintain top of pipe level.
- V. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- W. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- X. Refrigerant Piping:
1. Install systems in accordance with ASHRAE Standard 15.
 2. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
 3. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
 4. Flood piping system with nitrogen when brazing.
 5. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
 6. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
 7. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
 8. Fully charge completed system with refrigerant after testing.
- Y. Leave joints, including welds, uninsulated and exposed for examination during test.
- Z. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
- AA. Flush system with clean water. Clean strainers.
- AB. Isolate equipment from piping. If a valve is used to isolate equipment, provide closure capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- AC. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- AD. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
 3. Check expansion tanks to determine that they are not air bound and that system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure not-to-exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs

does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least four hours, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

AE. Refrigerant Piping:

1. Test refrigeration system in accordance with ASME B31.5.
2. Pressure test system with dry nitrogen to 200 PSI. Perform final tests at 27-inches vacuum and 200 PSI using electronic leak detector. Test to no leakage.

AF. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the piping systems in service. Provide temporary connections for cleaning, purging, and circulating fluids through the piping system.

AG. Use temporary strainers and temporary pumps that can create fluid velocities up to 10 feet per second to flush and clean the piping systems. Do not use Owner's permanent strainers to trap debris during pipe flushing operations. Fit the temporary construction strainers with a line size blowoff valve.

AH. When constructing minor piping modifications or additions, verify with Owner if the Owner's pumps and strainers can be used for flushing and chemical cleaning operations. When the flushing and cleaning operations are complete, insure the strainer baskets and screens installed in the piping systems permanent strainers are replaced with clean elements. Keep temporary strainers in service until the equipment has been tested, then replace straining element with a new strainer and clean and deliver the old straining elements to Owner. Fit the Owner's strainers with a line size blowoff valve.

3.4 REFRIGERANT PIPING INSTALLATION

- A. Install per manufacturer's written instructions and requirements.
- B. See articles below for specific requirements.
- C. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- D. Remove scale and dirt on inside and outside before assembly.
- E. Prepare piping connections to equipment with flanges or unions.
- F. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- G. Install heating water, glycol, condenser water, piping to ASME B31.9 requirements.
- H. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- I. Install piping to conserve building space and to avoid interference with use of space.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Sleeve pipe passing through partitions, walls and floors allowing adequate space for pipe insulation.
- L. Slope piping at 0.2 percent upward in direction of flow and arrange to drain at low points.
- M. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- N. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

- O. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- P. Anchor piping for proper direction of expansion and contraction.
- Q. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- R. Pipe Hangers and Supports:
1. Install in accordance with Division 23, HVAC, Hangers and Supports.
 2. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 3. Place hangers within 12-inches of each horizontal elbow.
 4. Use hangers with 1-1/2-inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 7. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
 8. Provide copper plated hangers and supports for copper piping.
 9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- S. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- T. Provide access where valves and fittings are not exposed.
- U. Use eccentric reducers to maintain top of pipe level.
- V. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- W. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- X. Refrigerant Piping:
1. Install systems in accordance with ASHRAE Standard 15.
 2. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
 3. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
 4. Flood piping system with nitrogen when brazing.
 5. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
 6. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
 7. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
 8. Fully charge completed system with refrigerant after testing.
- Y. Leave joints, including welds, uninsulated and exposed for examination during test.

- Z. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
- AA. Flush system with clean water. Clean strainers.
- AB. Isolate equipment from piping. If a valve is used to isolate equipment, provide closure capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- AC. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- AD. Refrigerant Piping:
 - 1. Test refrigeration system in accordance with ASME B31.5.
 - 2. Pressure test system with dry nitrogen to 200 PSI. Perform final tests at 27-inches vacuum and 200 PSI using electronic leak detector. Test to no leakage.

END OF SECTION

SECTION 233100 HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Ductwork, Joints and Fittings
 - 2. Laundry Clothes Dryer Vent
 - 3. Insulated Flexible Duct
 - 4. Drain Pans
 - 5. Ductwork Joint Sealers and Sealants

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Section 23 05 29, Hangers and Supports for HVAC Piping, Ductwork and Equipment.
 - 2. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Welding Certificates
 - 2. Field Quality Control Reports

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. NFPA Compliance:
 - a. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
 - b. NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
 - 2. Comply with NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations, Ch. 3, Duct System for range hood ducts, unless otherwise indicated.
 - 3. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Provide sheet metal materials free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
 - 4. If required, provide ductwork pressure testing per Section 23 05 93, Testing, Adjusting and Balancing for HVAC.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Duct design is generally diagrammatic and is not meant to be scaled. Major changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ductwork, Joints, and Fittings:
 - 1. Ductmate
 - 2. Lindab Inc
 - 3. Nexus Inc
 - 4. SEMCO
 - 5. United McGill Corporation
 - 6. Ward Industries
 - 7. Or approved equivalent
- B. Insulated Flexible Duct:
 - 1. ATCO
 - 2. Flexmaster
 - 3. J.P. Lamborn Co.
 - 4. Hart and Cooley
 - 5. Or approved equivalent
- C. Drain Pans:
 - 1. Not applicable.
- D. Ductwork Joint Sealers and Sealants
 - 1. Ductmate
 - 2. Durodyne
 - 3. Hardcast
 - 4. United McGill Corporation
 - 5. Vulkem
 - 6. Or approved equivalent

2.2 DUCTWORK, JOINTS AND FITTINGS

- A. Materials:
 - 1. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, lock-forming quality, ASTM A 653/A 653M FS Type B, with G90/Z275 coating. Ducts to have mill phosphatized finish for surfaces exposed to view.
 - 2. Aluminum Ducts: ASTM B 209 (ASTM B 209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

3. Stainless Steel: Fabricated in accordance with ASTM A167 and A480.
- B. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems not-to-exceed deflection limits according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
 3. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
- C. Formed-On Flanges: construct according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 1-4, using corner, bolt, cleat, and gasket details.
1. Duct Size: Maximum 30-inches wide and up to 2-inch wg pressure class.
 2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
 3. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19-inches and larger and 0.0359-inch thick or less, with more than 10 SF of nonbraced panel area unless ducts are lined.
- D. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of material specified in this Section according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
1. Ducts up to 20-inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 2. Ducts 21- to 72-inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
 3. Ducts Larger than 72-inches in Diameter: Companion angle flanged joints per SMACNA HVAC Duct Construction Standards-Metal and Flexible, Figure 3-2.
 4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
- E. 90-Degree Tees and laterals and Conical Tees: Fabricate to comply with SMACNA's HVAC Duct Construction Standards-Metal and Flexible, with metal thicknesses specified for longitudinal-seam straight ducts.
- F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows to be 1.5 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's HVAC Duct Construction Standards-Metal and flexible, unless otherwise indicated.
 2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa):
 - a. Ducts 3- to 36-inches in Diameter: 0.034-inch.
 3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
 - a. Ducts 3- to 26-inches in Diameter: 0.034-inch.
 4. 90-Degree, two-piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
 5. Round Elbows

- a. 8-inches and Less in Diameter: Fabricate die-formed elbows for 45 and 90-degree elbows and pleated elbows for 30, 45, 60 and 90 degrees only. Fabricate nonstandard bend-angle configurations or non-standard diameter elbows with gored construction.
 - b. 9 through 14-inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60 and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 - c. Larger than 14-inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
- 6. Die-Formed Elbows for Sizes through 8-inches in Diameter and Pressures 0.040-inch thick with two-piece welded construction.
 - 7. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
 - 8. Pleated Elbows for Sizes through 14-inches in Diameter and Pressures through 10-inch wg (2500 Pa): 0.022-inch.

2.3 INSULATED FLEXIBLE DUCT

- A. Construction: Standard factory fabricated product. Inner wall: Impervious vinyl or chlorinated polyethylene, permanently bonded to a vinyl or zinc-coated spring steel helix.
- B. Insulation: Fiberglass blanket insulation covered by an outer wall of vinyl or fiberglass-reinforced metalized vapor barrier.
- C. Listing: UL 181 listed Class 1 flexible air duct material. Overall thermal transmission: No more than 0.25 BTU/in or hr/sq. degrees F at 75 degrees F differential, per ASTM C335.
- D. Vapor transmission value no more than 0.10 perm, per ASTM E96
- E. Pressure Rating: 4-inch wg positive pressure and 1-inch wg negative pressure.
- F. Performance Air Friction Correction Factor: 1.3 maximum at 95 percent extension. Working air velocity: Minimum 2000 FPM.
- G. Flame Spread Rating: No more than 25.
- H. Smoke Development Rating: No more than 50 as tested per ASTM E84.
- I. Insertion Loss: Minimum attenuation of 29 DB for 10-foot straight length at 8-inch diameter at 500 Hz.

2.4 DRAIN PANS

- A. Primary Drain Pans: Stainless Steel, Fabricated in accordance with ASTM A167 and A480.
- B. Secondary Drain Pans: Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS Type B, with G90/Z275 coating.

2.5 DUCTWORK JOINT SEALERS AND SEALANTS

- A. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
- B. Low Emitting Materials Requirement: Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
- C. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
- D. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.
- E. Water Based Sealant for Brush-On Application: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts. Min. 69

percent solids, nonflammable. Durodyne Duroseal, Hardcast Versa-Grip 181, McGill United Duct Sealer.

- F. Solvent Based Sealant for Brush-On Application: One-part, nonsag, solvent-release-curing, polymerized butyl sealant with a minimum of 75 percent solids, nonflammable. McGill Uni-Coat, Hardcast Sure-Grip, 404.
- G. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.
- H. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.
- I. Two-Part Tape and Adhesive System: Hardcast FTD 20/DT, McGill Air Seal Uni-Cast.
- J. Silicon Sealant: Hardcast PT-302 or equal.
- K. Polyurethane Sealant: General-purpose non-brittle sealant for gunned application. Vulkem 616 or equal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. General: Use the following pressure class(es) in design of ductwork specified in this section unless otherwise noted on Drawings.

SYSTEM	PRESSURE IP (inches of water)	CLASS METRIC
Medium pressure supply	0.5-inch higher than air handlers discharge pressure (min. 4-inch pressure class).	996.4 PA
Low pressure supply	+ 1-inch	249 PA
Return main (>24-inch)	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	-498.2 PA
Return branch (<24-inch)	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	-249 PA
General exhaust	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	-498.2 PA

- B. Ductwork Installation:

1. General: Install entire duct system in accordance with drawings, Specifications, and latest issues of local Mechanical Code, NFPA 90A, and SMACNA Duct Construction Manual. At Contractor's option, rectangular ductwork may be resized to maintain an equivalent air velocity and friction rate, while maintaining a maximum aspect ratio of 3. Remove markings and tagging from ductwork exterior surface in mechanical rooms and other locations where ductwork is exposed.
2. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate the ductwork routing and layout, and make alterations to the ductwork routing and layout to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, alterations may be made so as not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or duct run as shown on the Contract Drawings. In the event Architect determines that the installed ductwork is inconsistent with the above mentioned criteria, remove and replace at no additional cost to the Owner.
3. Install ducts with fewest possible joints.
4. Install fabricated fittings for changes in directions, size, shape, and for connections.

5. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12-inches, with a minimum of 3 screws in each coupling.
 6. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
 7. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
 8. Install ducts with a clearance of 1-inch, plus allowance for insulation thickness. Allow for easy removal of ceiling tile.
 9. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
 10. Coordinate layout with suspended ceiling, air duct accessories, lighting layouts, and similar finish work.
 11. Electrical and IT Equipment Spaces: route ducts to avoid passing through transformer vaults, electrical equipment spaces, IDF/MPOE rooms, and enclosures.
 12. Boiler Rooms and Refrigeration Machinery Rooms: Only route ducts serving these rooms through these rooms.
 13. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2-inches.
 14. Fire- and Smoke-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire, smoke or combination fire and smoke dampers as governed by Building Code and AHJ, including sleeves, and firestopping sealant.
 15. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Reference SMACNA's Seismic Restraint Manual: Guidelines for Mechanical Systems, Mason Seismic Restraint and Support Systems.
 16. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's Duct Cleanliness for New Construction Advanced Level.
 17. Paint interiors of metal ducts, that do not have duct liner, for 24-inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible duct material.
 18. Install ductwork in the location and manner shown and detailed. Review deviations required by job conditions with Architect prior to any fabrication. Provide fittings for construction per SMACNA.
- C. Flanged Take-Offs:
1. Install at branch takeoffs to outlets using round or flex duct.
 2. Flanged take-offs secured with minimum 8-inch screw spacing (three screws minimum).
 3. Provide ductwork taps and branches off of main ducts at 45 degrees whether shown on Drawings or not (drawings are diagrammatic).
- D. Cleaning:
1. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.
 2. Grille and Exposed Duct Cleaning:
 - a. After completion of ductwork installation, operate each fan system (excluding exhaust fans) for a minimum of 30 minutes prior to installation of ceiling grilles and diffusers. After grilles and diffusers are installed, clean out accumulation of particles from grilles and diffusers prior to acceptance.
 - b. Clean exterior surface of ducts exposed to public view of chalk, pencil and pen marks, labels, sizing tags, dirt, dust, etc., so that upon completion of installation, ducts are left in clean and unblemished manufactured conditions.

- c. Exposed duct and grilles to remain free of dust entrained streaks due to leakage at joints and grille connections during warranty period. Clean leaks, seal and refinish to match existing if visible streaks develop.

3.2 DUCTWORK, JOINTS AND FITTINGS INSTALLATION

A. Duct Materials - Applied Locations:

1. General: Use the following materials in design of ductwork specified in this Section unless otherwise noted on the Drawings.

Location or Application	Material
Supply, Return, Transfer, and Exhaust - Low Pressure	Single Wall, Galvanized Steel
Supply, Return, and Exhaust - Medium Pressure	Single Wall, Galvanized Steel
General Exhaust Branch Serving Air Inlet in Shower Room or Toilet Room with Shower	Single Wall, Aluminum or Type 304 Stainless Steel

B. Ductwork Installation:

1. Fabricate radius elbows with centerline radius not less than 1-1/2 duct diameters.
2. Do not install duct size transition pitch angles which exceed 30 degrees for reductions in duct size in the direction of airflow, and 15 degrees for expansions in duct size in the direction of airflow.
3. Install fixed turning vanes in square throat rectangular elbows and in tees.
4. In healthcare settings such as hospitals and medical office buildings, use radius elbows in return and exhaust applications (even where not shown as such on drawings) to avoid turning vanes within the return and exhaust air stream.
5. Fabricate duct turns with the inside (smallest) radius at least equal to the duct width (supply ducts) and 1.5 times radius (return and exhaust ducts). Where necessary, square elbows may be used, with maximum available inside radius and with fixed turning vanes. In healthcare settings such as hospitals and medical office buildings, square elbows and turning vanes allowed on supply ductwork only.

3.3 INSULATED FLEXIBLE DUCT INSTALLATION

- #### A. Install flexible duct with bend radius equal to 1.5 times the diameter. Minimum length 2-feet. Maximum length 5-feet, unless noted otherwise.
1. Provide round neck grilles/diffusers or square-to-round transitions. Flex duct connections directly to square neck not allowed.
 2. Flex duct allowed in concealed spaces above lay-in ceilings only.

3.4 DUCTWORK JOINT SEALERS AND SEALANTS INSTALLATION

A. Joints and Seam Joint Sealing:

1. Seal duct seams and joints according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible for duct pressure class indicated.
2. For pressure classes lower than 2-inch wg (500 Pa), seal transverse joints.
3. Seal ducts before external insulation is applied.
4. Tape joints of PVC coated metal ductwork with PVC tape.
5. Fasteners such as sheet-metal screws, machine screws or rivets to be cadmium plated.
6. Rectangular Ductwork: Where intermediate joint reinforcement is required for duct of negative pressure class, pre-drill stiffening flange and provide fastener maximum 8-inches on center. Where retaining flanges are welded to duct wall, paint welds with zinc coating.
7. Single Wall Round Ductwork: Joint to incorporate beaded slip collar with minimum #8 sheet metal screws 8-inches on center. Seal ductwork as specified in this Section.

8. Seal joints and seams. Apply sealant to make end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
9. Double Wall Round Ductwork: Joint to incorporate beaded slip collar or flanged connection, with minimum #8 sheet metal screws 8-inches on center. Seal ductwork as specified in this Section.
10. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
11. Provide openings in ductwork where required to accommodate thermometers and control devices. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
12. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities as well as Code required clearances.

END OF SECTION

SECTION 233300 AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Sheet Metal Materials
 - 2. Backdraft Dampers
 - 3. Dampers
 - 4. Concealed Damper Hardware
 - 5. Access Doors
 - 6. Duct Test Holes
 - 7. Control Dampers
 - 8. Flexible Connectors

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Manufacturer's catalog data and fabrication/installation drawings for each factory fabricated duct accessory. Include leakage, pressure drop and maximum back pressure data.
 - 2. Shop Drawings: Indicate air duct accessories.
 - 3. Manufacturer's installation instructions: Provide instructions for each factory fabricated duct accessory.
 - 4. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - a. See Division 01, General Requirements, Product Requirements for additional provisions.
 - b. Extra Fusible Links: One of each type and size.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Section, with minimum five years of documented experience.
 - 2. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
 - 3. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
 - 4. AMCA 511 - Certified Ratings Program for Air Control Devices.
 - 5. CSFM - California State Fire Marshal Listing for Fire Damper and Smoke Damper.
 - 6. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

7. NFPA 92A - Smoke-Control Systems.
8. NFPA 92B - Smoke Control Systems in Atria, Covered Malls and Large Areas.
9. NFPA 101 - Life Safety Code.
10. UL 555 - Standard for Safety; Fire Dampers.
11. UL 555S - Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Sheet Metal Materials:
 1. Not applicable.
- B. Backdraft Dampers:
 1. Air Balance
 2. Cesco
 3. Greenheck
 4. Nailor
 5. Ruskin
 6. Or approved equivalent.
- C. Dampers:
 1. Air Balance
 2. Cesco
 3. Greenheck
 4. Nailor
 5. Ruskin
 6. Or approved equivalent.
- D. Concealed Damper Hardware, Cable System:
 1. Young Regulator Company
 2. Or approved equivalent.
- E. Access Doors:
 1. Ductmate
 2. Cesco
 3. Ruskin
 4. Nailor
 5. Outdoor Installation: Karp MX insulated exterior access door.
 6. Or approved equivalent.
- F. Duct Test Holes:
 1. Ventlok
 2. Or approved equivalent.
- G. Control Dampers:
 1. Ruskin
 2. Greenheck

3. CESCO
4. Air Balance
5. Nailor
6. Or approved equivalent.

H. Flexible Connectors:

1. Duro Dyne Corp.
2. Ventfabrics Inc.
3. Ward Industries
4. Or approved equivalent.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M. Galvanizing: 1-1/4 ounces per square foot total both sides; ducts to have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480/A 480M.
- D. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063, temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

2.3 BACKDRAFT DAMPERS

- A. Basis-of-Design: Ruskin CB D6.
- B. Description: Multiple-blade gravity balanced with center pivoted blades with sealed edges, assembled in rattle free manner with 90-degree stop, adjustment device to permit setting for varying differential static pressure.
- C. Frame: 0.125-inch thick 6063-T5 extruded aluminum channel with galvanized steel braces at mitered corners. Provide mounting flange.
- D. Blades: Single piece, overlap frame, parallel action, horizontal orientation, minimum 0.07-inch 6063-T5 extruded aluminum material, maximum 6-inch width.
- E. Bearings: Corrosion-resistant synthetic, formed as single piece with axles.
- F. Blade Seals: Extruded vinyl, mechanically attached to blade edge.
- G. Blade Axles: Corrosion-resistant, synthetic formed as single piece with bearings, locked to blade.
- H. Tie Bars and Brackets: Galvanized steel.
- I. Return Spring: Adjustable tension.
- J. Damper Capacity:
 1. Closed Position: Maximum back pressure of 16-inches water gauge.
 2. Open Position: Maximum air velocity of 2,500-feet per minute.

- K. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade. Must be capable of operating over wide range of pressures.
- L. Finish: Mill aluminum.
- M. Temperature Rating: -40 degrees F to 200 degrees F.
- N. Operation of Blade:
 - 1. Start to Open: 0.01-inch wg
 - 2. Fully Open: 0.05-inch.
- O. Pressure Drop: Maximum 0.15-inch wg at 1,500-feet per minute through 24-inch by 24-inch damper.
- P. Factory Sleeve: Minimum 20 gauge thickness, 12-inches in length.
- Q. Screen: At outdoor intake or discharge. 1/4-inch aluminum.

2.4 DAMPERS

- A. Basis-of-Design: Ruskin MD 35.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
 - 1. Pressure Classes of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- C. Rectangular Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design with linkage concealed in frame and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum 16 gauge thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 - a. Roll-Formed Steel Blades: 16 gauge thick, galvanized sheet steel.
 - b. Aluminum Frames: Hat-shaped, 10 gauge thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 - c. Roll-Formed Aluminum Blades: 10 gauge thick aluminum sheet.
 - d. Extruded-Aluminum Blades: 16 gauge thick extruded aluminum.
 - e. Blade Axles: Minimum 1/2-inch diameter, plated steel, hex shaped, mechanically attached to blade.
 - f. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
 - g. Tie Bars and Brackets: Galvanized steel.
 - h. Mill galvanized.
 - i. Capacity:
 - 1) Closed Position: Maximum pressure of 3-inches wg.
 - 2) Open Position: Maximum air velocity of 1,500-feet per minute across 24-inch by 24-inch damper.
- D. Round Volume Dampers: Single-blade suitable for horizontal or vertical applications.
 - 1. Steel Frames: Galvanized, roll formed, minimum of 20 gauge thick with beads at each end.
 - 2. Blades: Minimum 20 gauge thick, galvanized sheet steel, round, single-piece.
 - 3. Aluminum Frames: Minimum 10 gauge thick aluminum sheet.
 - 4. Aluminum Blades: Minimum 10 gauge thick aluminum sheet.
 - 5. Extruded-Aluminum Blades: Minimum 16 gauge thick extruded aluminum.
 - 6. Blade Axles: Minimum 3/8-inch square, plated steel, mechanically attached to blade.
 - 7. Bearings: Molded synthetic sleeve, turning in hole in frame.

8. Finish: Mill galvanized.
 9. Capacity:
 - a. Closed Position: Maximum pressure of 3-inches wg
 - b. Open Position: Maximum air velocity of 1,500-feet per minute.
 10. Leakage: Maximum 40 cfm at 1-inch wg for 20-inches diameter damper.
 11. Pressure Drop: Maximum 0.02-inch wg at 1,500-feet per minute through 20-inch diameter dampers.
- E. Jackshaft: 1-inch diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
 2. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include 2-inch elevated platform for insulated duct mounting.

2.5 CONCEALED DAMPER HARDWARE

- A. Concealed Damper Hardware: For dampers above non-removable ceilings (gyp, plaster, decorative, etc.) where access panels have not been shown on Architectural drawings or in locations where dampers are more than 2-feet above the ceiling, provide:
1. Concealed Damper Regulator: Young Regulator Company Model 315 or approved equivalent.
 2. Cable System: Young Regulator Company or approved equivalent.
 3. Controller: Young Regulator Company 270-275 or approved equivalent.
 4. Control wrenches, wire stops, casing nuts, and stainless steel wire.
 5. Paint cover plate to match ceiling color or as directed by Architect.

2.6 ACCESS DOORS

- A. Duct Pressure Class 2-inch WC and Greater: Sandwich-type design with threaded locking bolt assembly. Closed cell neoprene gasket permanently bonded to inside panel. Zinc-coated steel wing nuts or polypropylene molded knobs with threaded metal inserts - zinc coated bolts sealed to inner panel.
- B. Duct Pressure Class 1-1/2-inch WC and Less: Galvanized steel assembly incorporating frame, door, hinges, and latch(es). Frame tabbed for attachment to duct panel. Double wall door panel with 1-inch insulation. Open cell neoprene gasket attached to frame. Cam latches for tight closure.
- C. Plenum Doors: Extruded aluminum frames with extruded santoprene seals. Double-wall 20 gauge galvanized steel door panel with fiberglass insulation.
- D. Size: Maximum size available to fit rectangular duct panel dimension or round duct diameter. Plenum doors minimum 2-feet wide by 4-feet high.
- E. For outdoor installation, only provide waterproof access doors installed vertically.

2.7 DUCT TEST HOLES

- A. Temporary Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.8 CONTROL DAMPERS

- A. Basis-of-Design:

1. Ruskin Model CD36, low leakage, for use in low pressure ductwork.
 2. Ruskin Model CDR25, low leakage, for use in low pressure round ductwork.
 3. Ruskin Model CDO25, low leakage, for use in low pressure oval ductwork.
 4. Ruskin Model CD60, ultra low leakage, for use in medium pressure ductwork.
- B. Fabrication:
1. Frame: 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gauge U-channel.
 2. Blades (Low Leakage Dampers):
 - a. Style: Single skin with 3 longitudinal grooves.
 - b. Action: Opposed blade for modulating applications, parallel blade for two position application.
 - c. Orientation: Horizontal or vertical with thrust washers.
 - d. Material: Minimum 16 gauge equivalent thickness, galvanized steel.
 - e. Width: Nominal 6-inches.
 3. Blades (Ultra Low Leakage Dampers):
 - a. Style: Airfoil-shaped, single-piece.
 - b. Action: Opposed blade for modulating applications, parallel blade for two position applications.
 - c. Orientation: Horizontal or vertical with thrust washers.
 - d. Material: Minimum 14 gauge equivalent thickness, galvanized steel.
 - e. Width: Nominal 6-inches.
 4. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
 5. Seals:
 - a. Blade: Inflatable PVC coated fiberglass material and galvanized steel. Mechanically attached to blade edge.
 - b. Jamb: Flexible metal compression type.
 6. Linkage: Concealed in frame.
 7. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade.
 8. Mounting: Vertical or horizontal.
 9. Finish: Mill galvanized for installation in galvanized sheet metal and Type 304 stainless steel for installation in stainless steel ductwork.
- C. Performance Data (Low Leakage Dampers):
1. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
 - a. Closed Position: Maximum pressure of 5-inches wg at a 12-inch blade length.
 - b. Open Position: Maximum air velocity of 2,000-feet per minute.
 2. Leakage: Maximum 3.7 cubic-feet per minute per square foot at 1-inch wg for sizes 36-inches wide and above.
 3. Pressure Drop: Maximum 0.07-inch wg at 1,500-feet per minute across 24-inch by 24-inch damper.
- D. Performance Data (Ultra Low Leakage Dampers):
1. Leakage: Damper to have a maximum leakage of 3 cfm per square foot at 1-inch wg and be AMCA licensed as Class 1A.
 2. Differential Pressure:
 - a. Damper to have a maximum differential pressure rating of 13-inch wg for a 12-inch blade.
 3. Velocity: Damper to have a maximum velocity rating of 6,000-feet per minute.
 4. Temperature: Damper rated for -72 degrees F to 275 degrees F.
 5. Pressure Drop: Maximum 0.1-inch wg at 2,000-feet per minute across 24-inch by 24-inch damper.
- E. Actuator: Provide actuator. See Specification Section 23 09 33, Electric and Electronic Control System for HVAC.

- F. Factory flange frame
- G. Factory Sleeve: Minimum 20 gauge thickness.
- H. Duct Transition Connection: Per Drawings.
- I. Factory Tests: Factory cycle damper assembly to assure proper operation.

2.9 FLEXIBLE CONNECTORS

- A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Metal-Edged Connectors: Factory fabricated with a fabric strip 4-inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Select metal compatible with ducts.
- C. Indoor System, Flexible Connector Fabric (FC-1): Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 ounces per square yard.
 - 2. Tensile Strength: 480 pounds of force per inch in the warp and 360 pounds of force per inch in the filling.
 - 3. Service Temperature: -40 degrees F to 200 degrees F.
- D. Outdoor System, Flexible Connector Fabric (FC-O): Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 ounces per square yard.
 - 2. Tensile Strength: 530 pounds of force per inch in the warp and 440 pounds of force per inch in the filling.
 - 3. Service Temperature: -50 degrees F to 250 degrees F.
- E. High-Temperature System, Flexible Connectors (FC-HT): Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 ounces per square yard.
 - 2. Tensile Strength: 285 pounds of force per inch in the warp and 185 pounds of force per inch in the filling.
 - 3. Service Temperature: -67 degrees F to 500 degrees F.
- F. High-Corrosive-Environment System, Flexible Connectors (FC-HC): Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 ounces per square yard.
 - 2. Tensile Strength: 450 pounds of force per inch in the warp and 340 pounds of force per inch in the filling.
 - 3. Service Temperature: -67 degrees F to 500 degrees F.

PART 3 - EXECUTION

3.1 DUCT ACCESSORIES GENERAL INSTALLATION

- A. Inspect areas to receive air duct accessories. Notify Engineer of conditions that would adversely affect the installation of the dampers. Do not proceed until conditions are corrected.
- B. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- C. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- D. Do not compress or stretch damper frames into duct or opening.

- E. Handle dampers using sleeve or frame. Do not lift dampers using blades, actuators, or jack shafts.
- F. Adjust duct accessories for proper settings.

3.2 SHEET METAL MATERIALS INSTALLATION

- A. Install bracing for multiple Sections to support assembly weights and hold against system pressure. Install bracing as needed.

3.3 BACKDRAFT DAMPERS INSTALLATION

- A. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated. Provide at outside air intakes where motorized dampers are not shown on drawings.

3.4 DAMPERS INSTALLATION

- A. Where installing volume dampers in ducts with liner, avoid damage to and erosion of duct liner.
- B. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts for air balancing. Install at a minimum of two duct widths from each branch takeoff. Provide balancing dampers for all air inlets and outlets.
- C. Install dampers square and free from racking with blade running horizontally.

3.5 CONCEALED DAMPER HARDWARE INSTALLATION

- A. Coordinate location in Reflected Ceiling Plan and color of concealed damper hardware with Architect prior to installation.

3.6 ACCESS DOORS INSTALLATION

- A. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. Downstream from volume dampers, turning vanes and equipment.
 - 3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
 - 4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
 - 5. Install the following sizes for duct-mounting, rectangular access doors:
 - a. One-Hand or Inspection Access: 8-inches by 5-inches.
 - b. Two-Hand Access: 12-inches by 6-inches.
 - c. Head and Hand Access: 18-inches by 10-inches.
 - d. Head and Shoulders Access: 21-inches by 14-inches.
 - e. Body Access: 25-inches by 14-inches.
 - f. Body Plus Ladder Access: 25-inches by 17-inches.
 - 6. Install the following sizes for duct-mounting, round access doors:
 - a. One-Hand or Inspection Access: 8-inches in diameter.
 - b. Two-Hand Access: 10-inches in diameter.
 - c. Head and Hand Access: 12-inches in diameter.
 - d. Head and Shoulders Access: 18-inches in diameter.
 - e. Body Access: 24-inches in diameter.
 - 7. Label access doors.

3.7 DUCT TEST HOLES INSTALLATION

- A. Provide test holes at fan inlets and outlets where indicated and where required for air testing and balancing.

3.8 CONTROL DAMPERS INSTALLATION

- A. Handle dampers using sleeve or frame. Do not lift dampers using blades, actuators or jack shafts.
- B. Install control dampers in accordance with manufacturer's written instructions.

3.9 FLEXIBLE CONNECTORS INSTALLATION

- A. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators. Provide sheet metal weather cover over flexible connections located outdoors. Attach sheet metal to either equipment side or ductwork side, but not both.
- B. Per NFPA, do not use flexible connectors on grease exhaust fans
- C. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- D. Adjust the following types in the following locations:
 - 1. FC-1: Indoors
 - 2. FC-O: Outdoors
 - 3. FC-HT: High temperature exhaust systems and smoke removal systems.
 - 4. FC-HC: High corrosive systems inclusive of all laboratory exhaust systems.

END OF SECTION

SECTION 233400 HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Ceiling Exhaust Fans

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material gauges and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Motors: Electrically Commutated Motors (ECM) where scheduled on Drawings.
 - 2. Sound power levels as scheduled on Drawings. If not scheduled, within 5 percent of Basis of Design at design flow.
 - 3. Project Altitude: Base air ratings on sea-level conditions for project sites below 2,000 feet in elevation. Base air ratings on actual site elevations for project sites above 2,000 feet in elevation.
 - 4. Operating Limits: Classify according to AMCA 99.
 - 5. 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.
 - 6. AMCA Compliance: Products are to comply with performance requirements and are to be licensed to use the AMCA-Certified Ratings Seal.
 - 7. NEMA Compliance: Motors and electrical accessories are to comply with NEMA standards.
 - 8. UL Standard: HVAC Fans are to comply with UL 705. Fans used in grease exhaust applications are to be UL 762 listed for grease exhaust.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ceiling Exhaust Fans:
 - 1. Cook
 - 2. Greenheck
 - 3. Carnes
 - 4. Broan
 - 5. PennBarry
 - 6. Twin City
 - 7. Or approved equivalent.

2.2 CEILING EXHAUST FANS

- A. Description: Centrifugal fan, direct drive, cabinet and exhaust grille. AMCA rated. Sound level as scheduled or less. Fan shrouds, motor, and fan wheel are to be removable for service.
- B. Wheel: Double width, double inlet, forward curved blades:
- C. Housing: Acoustically insulated steel casing, factory standard finish, bottom access through grille, ducted outlet, egg crate inlet grille. Provide stainless steel grille where scheduled.
- D. Drives: Direct drive.
- E. Back draft damper.
- F. Accessories:
 - 1. Disconnect plug.
 - 2. Flat roof cap.

3. Hooded wall cap.
 4. Pitched roof cap.
 5. Elbow discharge with grille.
 6. Louvered wall discharge with bird screen.
- G. Motor: Integrally mounted with pre-lubricated sealed ball bearings.
1. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.
 2. Disconnect Switch: Where not shown on Division 26, Electrical Drawings, provide nonfusible type, with thermal-overload protection mounted inside fan housing factory wired through an internal aluminum conduit.
 3. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 4. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 5. Motion Sensor: Motion detector with adjustable shutoff timer.
 6. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.
- H. Filter: Washable aluminum to fit between fan and grille.
- I. Isolation: Rubber-in-shear vibration isolators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install in accordance with manufacturer's instructions.
- B. Fans used for exhaust of moist air are to be constructed of aluminum construction and be warranted for their application in moist conditions.
- C. Support suspended units from structure threaded steel rods and vibration isolation device scheduled on Drawings.
- D. In seismic zones, restrain support units.
- E. Install units with clearances for service and maintenance.
- F. Provide fixed sheaves required for final air balance.
- G. Provide safety screen where inlet or outlet is exposed.
- H. Pipe scroll drains to nearest floor drain.
- I. Provide backdraft dampers on discharge of exhaust fans and as indicated on Drawings.
- J. Duct installation and connection requirements are specified in other Division 23, HVAC Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors per Section 23 33 00, Air Duct Accessories.
- K. Ground equipment.
- L. 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.
- M. Equipment Startup Checks:
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Verify lubrication from bearings and other moving parts.
 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 7. Disable automatic temperature-control operators.
- N. Starting Procedures:
1. Energize motor and adjust fan to indicated rpm.
 2. Measure and record voltage and amperage.
- O. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
- P. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- Q. Shut unit down and reconnect automatic temperature-control operators.
- R. Replace fan and motor pulleys as required to achieve design airflow.
- S. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- T. Adjust damper linkages for proper damper operation.
- U. Adjust belt tension.
- V. Lubricate bearings.
- W. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- X. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- Y. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

3.2 CEILING EXHAUST FANS

- A. Ceiling Exhaust Fans: Suspend units from structure; use steel wire or metal straps.
- B. See 3.1, General Installation Requirements above.

END OF SECTION

SECTION 233500 REFRIGERATION DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. General
 - 2. Refrigerant Monitor
 - 3. SCBA
 - 4. Control Cable

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 DEFINITIONS

- A. CMOS: Ceramic metal-oxide semiconductor.
- B. HFC: Hydrofluorocarbon.
- C. IR: Infrared.
- D. LED: Light-emitting diode.
- E. ppm: Parts per million.
- F. SCBA: Self-contained breathing apparatus.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Refrigerant Monitor:
 - 1. Davis Instruments Manufacturing Co., Inc.
 - 2. Foxboro Company

3. General Analysis Corp.
 4. Genesis International Inc.
 5. Thermal Gas Systems, Inc.; Haloguard Monitors.
 6. Trane Co.
 7. Or approved equivalent.
- B. SCBA:
1. AFC International, Inc.
 2. Clarey's Safety Equipment, Inc.
 3. Genesis International Inc.
 4. MSA, Instrument Division
 5. Thermal Gas Systems, Inc.; Haloguard Monitors
 6. Or approved equivalent.
- C. Control Cable:
1. Honeywell
 2. AMAT
 3. Or approved equivalent.

2.2 GENERAL

- A. Functional Description of Refrigerant Monitoring System:
1. On leak detection by refrigerant sensor(s), the system to perform the following:
 - a. Activate machinery room ventilation.
 - b. Activate audio and visual alarm inside and outside machinery room.
 - c. Notify Building Automation System of alarm condition.
 2. Source Quality Control:
 - a. SCBA: Tested and certified by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration according to 42 CFR 84, Subpart H.
 - b. Refrigerant Monitor: Factory tested and certified.

2.3 REFRIGERANT MONITOR

- A. Description: CMOS or IR sensor to continuously measure and display the specific gas concentration and be capable of indicating, alarming, and shutting down equipment, and automatically activating ventilation system. Provide monitor design and construction compatible with temperature, humidity, barometric pressure, and voltage fluctuations of the machinery room operating environment.
- B. Performance Requirements:
1. Refrigerant to Be Monitored: Manufacturer to match refrigerant type to purchased equipment for project.
 2. Refrigerant Concentration: 0 to 1000 ppm.
 3. Accuracy: 100 to 1000 ppm; plus or minus 10 percent of reading.
 4. Linearity: 100 to 1000 ppm; plus or minus 2 percent of full scale.
 5. Sensitivity: 1 ppm.
 6. Resolution: 1 ppm.
 7. Operating Temperature: 41 to 104 deg F.
 8. Response Time: 90 percent of a step change in 4 minutes.
 9. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range.
- C. Operating Requirements:
1. Maximum Power Input: 120-V ac; 60 Hz, 30 W.
 2. Alarm Relays: 3 relays at 5- to 8-A resistive load.

3. Alarm Set Points: Displayed on front of meter.
 4. Audible Output: Sonic alert at 75 to 80 dB at 60-inches.
 5. Analog Output: 0- to 10-V dc or 4- to 20-mA current sourcing.
 6. Serial Output Type: RS 232.
- D. Sensor Configuration: CMOS sensor.
1. Single-sensing channel.
 2. Expandable to four channels.
- E. Display: 10-character, alphanumeric, vacuum-fluorescent indicating lights for each alarm set point; standard alarm; acknowledge switch and test switch mounted on front panel; and alarm status LEDs and service fault LEDs. Enclosure: NEMA 250, type as required for ambient condition.
- F. Alarm Output: Indicating light flashes and horn sounds.
1. Remote unit for mounting outside machinery room and having light beacon with multiple lights.
 2. Field-adjustable alarm set points.
- G. Calibration: Factory calibrated.
- H. Battery: Provide integral battery system for secondary source of power. Battery standby time at full load: 2 hours minimum (longer if required by Code or local AHJ).

2.4 SCBA

- A. Description: Open-circuit, pressure-demand, compressed-air SCBA includes completely assembled, portable, self-contained devices designed for hazardous breathing environment application.
- B. Face Piece: EPDM construction material, one-size-fits-all with double-sealing edge, stainless-steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in mask, close-fitting nose piece to ensure no CO₂ build-up, and perspiration drain to avoid skin irritation and to prevent eyepiece, spectacle, and lens fogging.
- C. Backplate: Orthopedically designed of high-strength chemical and impact-resistant glass-fiber composite.
- D. Harness and Carrier Assembly: Large triangular back pad, backplate, and adjustable waist and shoulders straps. Modular in design, detachable components, and easy to clean and maintain. Shoulder straps are padded with flame-resistant material and reinforced with stainless-steel cable and attached with T-nuts, washers, and screws; rivets are not permitted.
- E. Air Cylinder: 45-minute, low-pressure, air-supply-loaded aluminum cylinders fitted with quick-fill assembly for refilling and air transfer.
- F. Wall-Mounted Case: Leakproof, corrosion-resistant, tough, plastic case.

2.5 CONTROL CABLE

- A. Provide electronic and fiber-optic cable for control wiring as specified in Division 26, Electrical.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Examine chiller layout for proper location of monitoring device.
- B. Verify refrigerant contained in chiller(s) to ensure compatibility of refrigerant monitor.

- C. Examine machinery room ventilation system to verify its operation with refrigerant monitor(s).
- D. Install refrigerant monitoring equipment level and plumb.
- E. Install labels and nameplates to identify monitoring devices and SCBA components.
- F. Install building wire and cable according to Division 26, Electrical Specifications.
- G. Install signal and communication cable according to Division 26, Electrical Specifications.
- H. Run air-sampling tubing from monitor to air-sampling point, in size as required by monitor manufacturer. Install tubing with maximum unsupported length of 36-inches, for tubing exposed to view. Terminate air-sampling tubing at sampling point with filter recommended by monitor manufacturer.
- I. Install air-sampling tubing with sufficient slack and flexible connections to allow for vibration of tubing and movement of equipment.
- J. Purge air-sampling tubing with dry, oil-free compressed air before connecting to monitor.
- K. Number-code or color-code air-sampling tubing for future identification and service of air-sampling multiple-point monitors.
- L. Extend air-sampling tubing from exhaust part of multiple-point monitors to outside.
- M. Retain paragraph below for NDIR monitors. Delete for other types of monitors.
- N. Extend air-sampling tubing from outdoors to outdoor inlet connection of NDIR monitors. Terminate air-sampling tubing at outdoor inlet location with filter recommended by monitor manufacturer.
- O. Place warning signs inside and outside each door to the refrigeration equipment room. Sample wording: "AUDIBLE AND VISUAL ALARM SOUNDING INDICATES REFRIGERANT DETECTION - ENTRY REQUIRES SCBA."
- P. Audible Alarm-Indicating Devices: Install at each entry door to refrigeration equipment room, and position not less than 6-inches below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- Q. Visible Alarm-Indicating Devices: Install adjacent to each alarm horn at each entry door to refrigeration equipment room, and position at least 6-inches below the ceiling.
- R. System supplier to have turnkey responsibility to provide mechanical and electrical installation, provide on-site installation supervision, and properly locate sampling points after review of refrigeration machinery room air flow and ventilation patterns.
- S. Air flow profile tests to be turned over to Owner as part of the safety certification documentation. Final location of sample points to be determined after chiller room ventilation systems and equipment have been installed, and properly balanced. It is the system suppliers responsibility to insure that enough sample points exist to properly monitor air samples both under normal ventilation conditions and under purge ventilation conditions. Air profile test to indicate air flow pattern prior to alarm and after alarm to insure that safe monitoring exists under both conditions.
- T. Install equipment in accordance with applicable codes and manufacturer's printed instructions. Route conduits and tubing as required to make neat and operating system. Sample inlet tubing to be 1/4-inch o.d. rigid copper, properly supported, and run neatly parallel with, or at right angles to building construction. Tubing to be void of kinks, sags and other irregularities. Bends made with a tube bender.
- U. Provide alarm points as digital inputs to the Building Management System.
- V. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with requirements.
 2. Test and adjust controls and safeties.
 3. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- W. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- X. Safety Certification:
1. Furnish Owner with Safety Certification documentation including the following: Air Flow Profile Report for each sample point location, Calibration Report with before and after results of each analyzer, Alarm / Interface Report stating threshold levels, alarm and interface action at each level of alarm with field verification report, Safety Training Checklist, and List of Owner attendees.
 2. Near end of warranty period of operation, provide similar service as described above complete with written report. Should a control or device be suspect in its operation or function, this deficiency to be reported to operating personnel, documented in report, and replaced.
 3. Post Construction On Site Service: Each six months after final acceptance until warranty expires, systematically inspect, examine, clean and adjust when necessary, detector, panels, relays, self contained breathing apparatus, and accessories pertaining to system. Provide updated pertinent reports.
- Y. Adjust alarm set points.
- Z. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.2 REFRIGERANT MONITOR

- A. See General Installation Requirements above.
- B. Install per manufacturers written instructions and requirements.
- C. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain refrigerant monitoring devices. Reference Division 01, General Requirements.

3.3 SCBA

- A. See General Installation Requirements above.
- B. Install per manufacturers written instructions and requirements.
- C. Training: Provide a "how-to-use" SCBA video that details exact operating procedures of equipment.

3.4 CONTROL CABLE

- A. See General Installation Requirements above.
- B. Install per manufacturers written instructions and requirements.

END OF SECTION

SECTION 233700 AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Grilles, Registers, Diffusers
 - 2. Louvers

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
 - 2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
 - 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size and accessories furnished.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Air Distribution Diffuser, Register, and Grille Schedule lists Basis of Design, with any specialty accessories, construction, finish or other criteria noted on schedule. Submitted air distribution must match criteria of Basis of Design:
 - a. Construction materials and appearance.
 - b. Frame/installation method.
 - c. Isothermal throw plus or minus 5 percent at design flows shown on drawings.
 - d. Noise Criteria: NC value plus or minus 1 at design flows shown on drawings.
 - e. Accessories: Equal to Basis of Design.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC sections, where more than a single type is specified for the application, provide single selection for each product category.
- B. Grilles, Registers, Diffusers:
1. Anemostat
 2. Carnes
 3. Environmental Air Products
 4. Kruger
 5. Metalaire
 6. Nailor
 7. Price Co.
 8. Shoemaker
 9. Titus
 10. Tuttle & Bailey
 11. Seiho
 12. Or approved equivalent.
- C. Louvers:
1. Ruskin Manufacturing
 2. Pottorff
 3. Carnes
 4. Cesco
 5. Greenheck
 6. Or approved equivalent.

2.2 GRILLES, REGISTERS, DIFFUSERS

- A. Diffuser, Register and Grille Schedule lists Basis of Design, with specialty accessories, construction, finish or other criteria noted on schedule. Submitted air distribution must match criteria of Basis of Design, including accessories and finish:
1. Matching construction materials and appearance. Equal installation method/frame.
 2. Pressure drop equal to or less than Basis of Design at CFM on Drawings.
 3. Throw: Isothermal jet throw plus or minus 5 percent of Basis of Design at CFM listed on Drawings.
 4. Noise Criteria: Plus or minus 1 NC of Basis of Design at CFM listed on Drawings. If Basis of Design NC is below registered level, submitted must match. NC rating with 10 dB room factor or less.
- B. Provide 1-, 2-, 3-, or 4-way deflection as indicated on Drawings.
- C. Register Dampers: Dampers utilized with grilles. Opposed blade dampers utilizing a side operated worm drive which provides external duct operation. Slot the end of the shaft to receive a screwdriver. Factory assembled side operator. Construct of the same material as the grille. Manufacturer same as grilles/diffuser.
- D. Coordinate mounting frames with ceiling construction type. Verify per reflected ceiling plans.

2.3 LOUVERS

- A. General: Frame and sill styles compatible with adjacent substrate, specifically manufactured to fit into construction openings with accurate fit and adequate support for weatherproof installation. Reference Drawings and Specifications for types of substrate which will contain each type of louver. Construct of aluminum extrusions, ASTM B221, Alloy 6063-T5. Weld units or use stainless steel fasteners. On inside face of exterior louvers, provide anodized aluminum wire bird screen mounted in removable extruded aluminum frames. AMCA licensed performance ratings.
- B. Blades set 3 to 5-inches on center, 37.5 degree angle with rain hook on blade, minimum blade thickness 0.080-inch, drainable blade style. Minimum 57 percent free area for 48-by 48-inch unit. Maximum water penetration 0.01 ounce water psf free area at 1000 FPM. Maximum intake pressure drop of 0.10-inch wg at 750 FPM free velocity. Provide downspouts in jambs, designed to drain water from louver for minimum water cascade from blade to blade. Provide drain gutter in head frame and each blade.
- C. Reference Drawings for free area required.
- D. Provide access door in duct to clean birdscreen.
- E. Finish: Factory Kynar 500 fluoropolymer spray finish color to be selected by Architect. Conform to AAMA 605.2. Apply coating following cleaning, and pretreatment. Dry louvers before final finish application. 1.2 mils total dry film thickness when baked at 450 degrees F for ten minutes.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install in accordance with manufacturer's instructions. Provide seismic supports, clips, and bracing per local code. Coordinate installation of framing. Provide complete coverage of rough openings by integral device flanges or auxiliary frames. Where above ceiling location is unconditioned space, caulk rough openings; repair and re-paint locations where dust entrainment streaks develop due to unsealed openings.
- B. Damp locations, such as lockers, restrooms, showers, natatoriums, whirlpool/spas, to have aluminum construction even if scheduled otherwise; mounting hardware to be stainless steel.
- C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- D. Adjust discharge direction and spread per Drawings. Adjust throws of air outlets to eliminate drafts and to distribute air during heating and cooling operation.
- E. Exterior color of grilles per Architect. White finish if not otherwise scheduled or noted by Architect. Paint ductwork visible behind air outlets and inlets matte black.
- F. Ceiling Membrane: Protect ceiling membrane per code. Fire caulk around openings. Provide listed radiation damper in rated roof/ceiling or floor/ceiling assemblies as required per code.
- G. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.2 GRILLES, REGISTERS AND DIFFUSERS INSTALLATION

- A. Coordinate with Architectural Reflected Ceiling Plan(s) and Floor Plans.
- B. Install diffusers to ductwork with air tight connection. 18-inch straight duct Section or acoustic plenum at connection. Provide square to round adapters where required for connection to round ducts.

- C. Provide integral balancing dampers for diffusers, and grilles and registers where duct manual balancing dampers are not shown or specified.

3.3 LOUVER INSTALLATION

- A. Install per manufacturer's recommendations.

END OF SECTION

SECTION 234000
HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Disposable Panel Filters

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. ARI 850 - Commercial and Industrial Air Filter Equipment; Air-Conditioning and Refrigeration Institute.
 - 2. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
 - 3. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
 - 4. Standard 52.2 - Method of testing general ventilation air-cleaning devices for removal efficiency by particle size.
 - 5. MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components, and Related Products: Performance-Test Methods; Military Specifications and Standards.
 - 6. UL 586 - High Efficiency, Particulate, Air Filter Units; Underwriters Laboratories Inc.
 - 7. UL 867 - Electrostatic Air Cleaners; Underwriters Laboratories Inc.
 - 8. UL 900 - Standard for Air Filter Units; Underwriters Laboratories Inc.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
 - 2. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.
 - 3. Samples: Submit two samples of replacement filter media of each type and each filter frame.
 - 4. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.
 - 5. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.
 - 6. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - a. See Division 01, General Requirements for additional provisions.
 - b. Extra Filters: One set of each type and size.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 PERFORMANCE REQUIREMENTS

- A. Conform to ARI 850, Standard for Performance Rating of Commercial and Industrial Air Filter Equipment, Section 7.4.
 - 1. Dust Spot Efficiency: Plus or minus 5 percent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Filters:
 - 1. American Filtration Inc.
 - 2. AAF International/American Air Filter
 - 3. Camfil Farr Company
 - 4. Eco-Air Products
 - 5. Filtration Group
 - 6. Flanders Corporation
 - 7. Or approved equivalent.
- B. Filter Gauges:
 - 1. Dwyer Instruments
 - 2. H.O. Treric Co.
 - 3. Weiss Instruments
 - 4. Or approved equivalent.
- C. Electronic Air Cleaners:
 - 1. Honeywell
 - 2. United Air Products Corp
 - 3. Universal Air Products
 - 4. Or approved equivalent.

2.2 DISPOSABLE PANEL FILTERS

- A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
 - 1. Nominal Size: 12 x 24-inches.
 - 2. Thickness: 1-inch.
- B. Performance Rating:
 - 1. Face Velocity: 500 FPM.
 - 2. Face Velocity: 350 FPM (2.54 m/sec).

3. Initial Resistance: 0.15-inch WG.
 4. Initial Resistance: 0.23-inch WG (37 Pa).
 5. Recommended Final Resistance: 0.50-inches WG.
 6. MERV Rating: 8.
- C. Casing: Cardboard frame.
- D. Holding Frames: 20 gauge minimum galvanized steel frame with expanded metal grid on outlet side and steel rod grid on inlet side, hinged with pull and retaining handles.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Provide and install filter gauge static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position/location. Adjust and level.
- D. Operation During Construction: If air handlers are operated during construction, provide treated 2-inch media construction filter in front of prefilters and replace periodically to prevent dirt carryover. Install clean prefilters prior to air balancing.
- E. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.
- F. Provide filter gauges on filter banks, installed with separate static pressure tips upstream and downstream of filters.

G. SCHEDULES

1. Air Filter Schedule
2. Drawing Code
3. Location
4. Type
5. Number
6. Size
7. Air Flow
8. Face Velocity
9. Overall Height
10. Overall Width
11. Initial Resistance
12. Final Resistance

3.2 DISPOSABLE PANEL FILTERS

- A. See 3.01 General Installation Requirements.
- B. Install per manufacturers written instructions and guidelines.

END OF SECTION

**SECTION 235100
BREECHINGS, CHIMNEYS AND STACKS**

WORK INCLUDED:

1.1 SUMMARY

- A. Work Included:
 - 1. Gas-Fired Equipment Vents

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. ASTM C 401 - Standard Classification of Alumina and Alumina-Silicate Castable Refractories, current edition.
 - 2. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; National Fire Protection Association, current edition.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 DEFINITIONS

- A. Vent: That portion of venting system designed to convey flue gases directly outdoors from vent connector or from an appliance when vent connector is not used.
- B. Vent Connector: That part of venting system that conducts flue gases from flue collar of an appliance to chimney or vent, and may include draft control device.

1.8 DESIGN REQUIREMENTS

- A. Selected condensing boiler or condensing gas equipment manufacturer to design and select venting system (intake and relief) per CMC and NFPA 211.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Gas-Fired Equipment Vents:

1. Positive Pressure ABS/PVC Vent:
 - a. Charlotte Pipe
 - b. Or approved equivalent.

2.2 GAS-FIRED EQUIPMENT VENTS

- A. Positive Pressure ABS/PVC Vent
 1. Schedule 40, pressure-rated ABS or PVC pipe; must meet gas-fired equipment manufacturer requirements for installation (solid core or otherwise to meet temperature requirements).
 2. Combination vent/intake from manufacturer, sidewall flashing.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install in accordance with manufacturer's written instructions and guidelines.
- B. Install in accordance with NFPA 54.

3.2 GAS-FIRED EQUIPMENT VENTS

- A. General: Vent-type to match equipment manufacturer requirements: Category 4. Maintain clearances to combustible materials per code; double-wall, insulation, thimbles, etc. at reduced clearance locations as necessary. Vent termination clearances from buildings, building openings, ventilation intakes, etc. per code.
- B. Pressurized Gas-Fired Vents:
 1. Install venting in accordance with the manufacturer's recommendations and the requirements of the UL listing of the system. Concentric vent/intake systems to be installed per manufacturer's recommendations.
 2. Maintain slope of vent per manufacturer's recommendations. Clearances to other buildings, openings, intakes, etc. per code unless otherwise indicated.
 3. ABS or PVC venting systems to be sized per manufacturer recommendations for minimum and maximum lengths. Total developed length must not exceed equipment listing; additional elbows may be required to meet minimum developed length.

END OF SECTION

SECTION 235500 FUEL FIRED HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included:
 - 1. Gas Fired Duct Furnaces

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Gas Fired Duct Furnace:
 - 1. Trane
 - 2. Or approved equivalent.

2.2 GAS FIRED DUCT FURNACES

- A. Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, heat exchanger with primary and secondary stages, burner, controls, and accessories.
- B. Cabinet:
 - 1. Cabinet 20 gauge aluminum steel, easily removed and secured access doors, glass fiber insulation and reflective liner.
 - 2. Gas Burner:
 - a. Atmospheric type with adjustable combustion air supply.
 - b. Gas valve, two stage provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
 - c. Electronic pilot ignition, with electric spark igniter.
 - d. Combustion air damper or Automatic vent damper with synchronous spring return damper motor.

3. Heat exchanger: Aluminized Steel or Stainless Steel.
 4. Supply Fan: Double width, double inlet, forward curve, centrifugal, belt drive.
 5. Supply Fan Motor: Two speed, ODP, 1800/900 RPM, HP volts and phase as scheduled.
 6. Filter: One-inch thick, Merv 8, pleated, glass fiber, throw-away.
- C. Controls:
1. Operational Controls: Room Thermostat.
 2. Gas Burner Safety Controls:
 - a. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
 - b. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
 - c. Sealed combustion air pressure switches to verify proper flow for gas valve operation.
- D. Performance: As scheduled.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Installation:
1. Install in accordance with NFPA 90A, including manufacturer's installation instructions.
 2. Install gas fired units in accordance with NFPA 54 and applicable codes.
 3. Provide vent connections in accordance with NFPA 211.
 4. Install unit heaters with vibration isolation.
 5. Install low voltage thermostats where shown on Drawings.
 6. Provide connection to electrical power and low voltage power systems coordinate with Division 26.
- B. Examination:
1. Verify space is ready for installation of units and openings are as indicated on shop drawings.
 2. Verify proper power supply is available.
 3. Verify proper fuel supply is available for connection.
- C. Schedules: See Drawings.

3.2 GAS FIRED DUCT FURNACES

- A. Install per manufacturers written instructions and requirements.
- B. See General Installation Requirements above.
- C. Schedules: See Drawings.

END OF SECTION

SECTION 238126
SMALL SPLIT SYSTEM AND UNITARY HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included: Materials, installation and testing of:
 - 1. Split System Condensing Unit
 - 2. Split System Indoor Fan Coil Unit
 - 3. Gas Fired Condensing Furnace, High Efficiency

1.2 RELATED SECTIONS

- A. Contents of Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.
- B. In addition, meet the following:
 - 1. ARI 210

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.
- B. In addition, provide:
 - 1. Samples: Submit one sample of wall louver.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.
- B. In addition, meet the following:
 - 1. Efficiency ratings, cooling/heating performance, fan performance, sound performance to meet or exceed Basis of Design as scheduled on Drawings.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.
- B. In addition, provide:
 - 1. Refrigeration compressor(s): 5-year warranty.
 - 2. Furnace heat exchanger: 5-year warranty.

1.7 PACKAGED TERMINAL AIR CONDITIONER MOCK-UP

- A. Install one unit that includes inside cabinet, wall sleeve, and wall louver.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Split System Condensing Unit:
 - 1. Trane
 - 2. Or approved equivalent.
- B. Split System Indoor Fan Coil Unit:
 - 1. Trane
 - 2. Or approved equivalent.
- C. Gas Fired Furnace, High Efficiency:
 - 1. Trane
 - 2. Or approved equivalent.

2.2 SPLIT-SYSTEM CONDENSING UNIT

- A. Description: Cooling operation, Energy Star labeled. Unit matched to indoor evaporator fan unit, coil, or furnace.
- B. Cabinet: Fabricated of galvanized steel and finished with powder coated baked enamel with Hail Guard.
- C. Refrigeration System:
 - 1. HFC Refrigerant or other refrigerant with zero ozone depletion potential (ODP).
 - 2. Hermetically sealed compressor, high-efficiency, variable speed compressor, integral high/low pressure and temperature protection, liquid line filter dryer.
 - 3. Options:
 - a. Long Line Accessory Kit
 - b. Solenoid Valve
 - c. Crankcase Heater
- D. Condenser Air System:
 - 1. Condenser Fan: Propeller type with direct drive motor, low sound generator.
 - 2. Condenser Fan Motor: Premium efficiency, permanently lubricated, totally enclosed with built-in current and thermal overload protection.
 - 3. Condenser Coil: Copper tubes mechanically bonded into aluminum fins.
 - a. Provide corrosion protection coating.
 - b. Provide Hail Guard.
- E. Condensate: Collection in galvanized steel drain pan sloped to drain away from the unit.
- F. Controls: Completely internally wired, microprocessor, high and low pressure cutouts, contractors and internal overload protection on all motors. Provide low ambient operation to 40 degrees F outside to maintain condensing temperature on part load operation. Provide anti-short cycle timer and time delay between compressor operation.

2.3 SPLIT-SYSTEM INDOOR FAN COIL UNIT

- A. Indoor fan unit matched to outdoor condensing unit. Self-contained, packaged, factory-assembled, pre-wired unit with direct expansion evaporator coil, cabinet supply fan, filter housing and controls. Accessories, economizer assembly, etc. as scheduled and shown on Drawings.
- B. Components:
 - 1. Steel cabinet with baked enamel finish; minimum 1/2-inch thick, 1-1/2# liner with cleanable facing or solid interior metal panel, filter housing suitable for 1-inch thick filter. Easily removed access panels.

2. Economizer/Mixing Box with damper actuator.
- C. Refrigeration System: HFC Refrigerant or other refrigerant with zero ozone depletion potential (ODP).
- D. Air System:
1. Supply Fan (Evaporator Fan): centrifugal multi-speed direct drive with internal vibration isolation.
 2. Evaporator Motor: Premium efficiency with permanently lubricated bearings thermal overload protection.
 3. Evaporator Coil: Seamless copper tubes expanded into aluminum fins. Galvanized or polymer drain pan sloped in all directions.
 4. Filter: MERV 8, 1-inch thick, pleated, throw-away.
 5. Supplemental Heat Coil:
 - a. Electric Heat Coil: UL Listed with helix wound bare nichrome wire heating elements. Heat output and staging as scheduled. Power usage per stage is not to exceed 5 kilowatts. Staging of coil heat internally controlled.
- E. Condensate:
1. Condensate pump kit.
 2. Secondary drain pan; Condensate overflow shut-off float switch and external alarm.
- F. Controls: Factory-wired to internal terminal strip or board for connection to programmable thermostat.
- G. Electrical: Furnish magnetic contactors. Arrange for single point electrical connection. Provide all associated field wiring.

2.4 GAS FIRED CONDENSING FURNACE, HIGH EFFICIENCY

- A. Self-contained, packaged, factory-assembled, pre-wired unit with direct expansion-evaporator coil, cabinet, supply fan, heating element, controls, air filter housing, and wired for single point connection. Unit to be Energy Star Labeled.
- B. Components:
1. Cabinet: Steel with baked enamel finish; minimum 1/2-inch thick, 1-1/2# liner with cleanable facing. Easily removed access panels. Filter housing suitable for 2-inch thick filter.
 2. Burner: Forced draft blower with SiN.
 3. Provide burner converted to L.P. Gas.
 4. Provide vent termination kit for roof or wall.
 5. Heat Exchanger: Constructed of heavy gauge aluminized steel or stainless steel.
- C. Refrigeration System: HFC Refrigerant or other refrigerant with zero ozone depletion potential (ODP).
- D. Air System:
1. Supply Fan: Forward curve direct drive upflow.
 2. Supply Fan Motor: Multi-speed, premium efficiency.
 3. Filter: MERV 8, two-inch thick, pleated, throw-away.
 4. Evaporator Coil (A-Frame Cooling Coil):
 - a. Direct expansion with seamless copper tubes expanded into aluminum fins.
 - b. Integral galvanized or polymer drain pan sloped in all directions, with insulation.
 - c. Drain pan overflow connection.
 - d. ARI certified.
- E. Condensate Drain:
1. Condensate pump kit.

2. Secondary drain pan; Condensate overflow shut-off float switch and external alarm.
- F. Controls: Modulate gas flow to optimize fuel efficiency and maintain temperature set point, variable speed fan control, full combustion control, factory mounted, wired, and tested in the equipment.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install with required clearances and access for maintenance.
- B. Install factory furnished devices for field installation.
- C. Inspect for and remove shipping bolts, blocks and tie-down straps.
- D. After energizing units: Test units for proper fan rotation. Test and adjust controls and internal safeties. Replace malfunctioning units and retest.
- E. Thoroughly clean exposed portions of equipment. Install new filters prior to final test and balance and again prior to final acceptance.

3.2 SPLIT SYSTEM CONDENSING UNIT INSTALLATION

- A. Provide vibration isolation: As scheduled.
- B. Provide Seismic restraint.

3.3 SPLIT SYSTEM INDOOR FAN COIL UNIT INSTALLATION

- A. Provide Seismic restraint.
- B. Condensate piped to indirect waste connection; cleanouts at changes of direction; sized and sloped to drain per Code. Secondary drain pan with float switch.

3.4 GAS FIRED FURNACE, HIGH EFFICIENCY INSTALLATION

- A. Provide Seismic restraint.
- B. Furnace condensate drain per manufacturer's piping diagram.
- C. Condensate piped to indirect waste connection; cleanouts at changes of direction; sized and sloped to drain per Code. Secondary drain routed to visible location.

END OF SECTION

SECTION 238216 AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Materials, installation and testing of:
 - 1. Direct Expansion Refrigerant Coils

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements
- B. In addition, provide:
 - 1. Product data for each coil including performance, dimensions, operating weights, pressure ratings.
 - 2. Computer selection sheet indicating performance including hot and cold side entering and leaving fluid/air conditions, flows, pressure drops, square feet of heating surface, fouling factor, and heat transfer surface dimensions and configuration.
 - 3. Refrigerant Coils: Provide capacity plot of suction pressure versus total load.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Coil capacity certified in accordance with ARI 410, latest edition.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Provide extended three year warranty for coils with corrosion protection coating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Direct Expansion Refrigerant Coils:
 - 1. Trane
 - 2. Or approved equivalent.

2.2 DIRECT EXPANSION REFRIGERANT COILS

- A. General: Extended surface type consisting of copper tubing mechanically expanded to bond with plate fins. Design for serpentine flow with one or more feeds from common supply and return headers. Arrange for counter flow operation.
- B. Performance: Provide capacity indicated with refrigerant type and suction pressure scheduled.
- C. Factory Testing: Leak test coils under water at 300 PSIG minimum.
- D. Working Pressure: 50 percent greater than refrigerant suction pressure.
- E. Construction:
 - 1. Tubing: seamless copper.
 - 2. Fins: copper die formed plates. Continuous within the coil casing.
 - 3. Casing: 16 gauge galvanized steel.
 - 4. Headers: Seamless copper tube brazed to heat transfer tubes.
 - 5. Connections: Same end for supply and return unless noted otherwise. Provide refrigerant distributor with equal length feeds to each tube. Provide hot gas bypass connection at distributor where scheduled.
 - 6. Circuiting: Provide face split configuration with suction header for each circuit.
 - 7. Intermediate Supports: Provide for coils with finned length greater than 44-inches, with maximum spacing of 42-inches.
- F. Corrosion Protection: Baked on phenolic coating suitable for 3000 hours salt spray per ASTM-B117. Heresite P413.

PART 3 - EXECUTION

3.1 REFRIGERANT COIL INSTALLATION

- A. Comb damaged and bent fins.
- B. Install equalizer and remote bulb sensing lines.
- C. Provide drain pan for ducted applications.
- D. Comb damaged and bent fins.
- E. Install coils to drain in accordance with manufacturer's written instructions and written recommendations.
- F. Install filters upstream of supply and exhaust air handler coils prior to fan operation.
- G. Pipe drain connection to indirect waste receiver or floor drain.
- H. For duct mounted cooling coils, provide drain pan, provide drain piping to indirect waste receiver or floor drain.

END OF SECTION

SECTION 260000 ELECTRICAL BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in 26 00 00, Electrical Basic Requirements applies to Division 26, Electrical work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of electrical systems for proposed project.
- B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. Definitions:
 - 1. Provide: To furnish and install, complete and ready for intended use.
 - 2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
 - 3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
 - 4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
 - 5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.2 RELATED SECTIONS:

- A. Contents of Section applies to Division 26, Electrical Contract Documents.
- B. Related Work:
 - 1. Additional conditions apply to this Division including, but not limited to:
 - a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - b. Drawings
 - c. Addenda
 - d. Owner/Architect Agreement
 - e. Owner/Contractor Agreement
 - f. Codes, Standards, Public Ordinances and Permits

1.3 REFERENCES AND STANDARDS

- A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 26, Electrical Sections and those listed in this Section.
- B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 - 1. State of California:
 - a. CBC California Building Code
 - b. CEC California Electrical Code
 - c. CEC T24 California Energy Code Title 24

- d. CFC California Fire Code
- e. CMC California Mechanical Code
- f. CPC California Plumbing Code
- g. CSFM California State Fire Marshal
- h. DSA Division of State Architect Regulations and Requirements

C. General: Reference standards and guidelines include but are not limited to the latest adopted editions from:

1. ABA Architectural Barriers Act
2. ADA Americans with Disabilities Act
3. ANSI American National Standards Institute
4. APWA American Public Works Association
5. ASCE American Society of Civil Engineers
6. ASHRAE Guideline 0, the Commissioning Process
7. ASTM ASTM International
8. CFR Code of Federal Regulations
9. CSA CSA International
10. EEMAC Electrical Equipment Manufacturers Association of Canada
11. EPA Environmental Protection Agency
12. ETL Electrical Testing Laboratories
13. FCC Federal Communications Commission
14. FDA Food & Drug Administration
15. FM FM Global
16. IBC International Building Code
17. IEC International Electrotechnical Commission
18. IEEE Institute of Electrical and Electronics Engineers
19. IES Illuminating Engineering Society
20. ISO International Organization for Standardization
21. MSS Manufacturers Standardization Society
22. NEC National Electric Code
23. NECA National Electrical Contractors Association
24. NEMA National Electrical Manufacturers Association
25. NETA National Electrical Testing Association
26. NFPA National Fire Protection Association
27. OSHA Occupational Safety and Health Administration
28. UBC Uniform Building Code
29. UL Underwriters Laboratories Inc.
30. USDA United States Department of Agriculture

D. See Division 26, Electrical individual Sections for additional references.

E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

1.4 SUBMITTALS

- A. See Division 01, General Requirements for Submittal Procedures as well as individual Division 26, Electrical Sections.
- B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.
- C. In addition:
 1. "No Exceptions Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
 2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. All transmissions/submissions to be submitted to Architect.
 3. Product Data: Provide manufacturer's descriptive literature for products specified in Division 26, Electrical Sections.
 4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the specifications and drawings.
 - a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
 - b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 26, Electrical specification Sections for specific items required in product data submittal outside of these requirements.
 - c. See Division 26, Electrical individual Sections for additional submittal requirements outside of these requirements.
 5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
 6. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
 7. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 26, Electrical Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
 8. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
 9. Substitutions and Variation from Basis of Design:
 - a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
 - b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or

equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

10. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 26, Electrical specification Sections for additional requirements for shop drawings outside of these requirements.
 - a. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
11. Samples: Provide samples when requested by individual Sections.
12. Resubmission Requirements:
 - a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
 - b. Resubmit for review until review indicates no exceptions taken or "make corrections as noted".
13. Operation and Maintenance Manuals, Owners Instructions:
 - a. Submit, at one time, one bound copy and electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
 - 1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
 - 2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment.
 - 3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
 - 4) Include product certificates of warranties and guarantees.
 - 5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
 - 6) Include commissioning reports.
 - 7) Include copy of startup and test reports specific to each piece of equipment.
 - 8) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
 - b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 26 00 00, Electrical Basic Requirements, Demonstration.
 - c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.
14. Record Drawings:

- a. Maintain at site at least one set of drawings for recording "As-constructed" conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of conduit, and location of concealed electrical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
- b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
- c. At completion of project, input changes to original project on CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
- d. See Division 26, Electrical individual Sections for additional items to include in record drawings.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed to conform with all local, State and Federal codes, and other applicable laws and regulations.
- B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e. distribution equipment, duct banks, light fixtures, etc.) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.
- C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- E. UL and CSA Compliance: Provide products which are UL listed

1.6 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.7 COORDINATION DOCUMENTS

- A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, lights, cable tray and electrical services with architectural and structural requirements, and other trades (including ceiling suspension and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
- B. Advise Architect in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
- C. Verify in field exact size, location, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

- D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide like items from one manufacturer.

2.2 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL or CSA approved or have adequate approval or be acceptable by state, county, and city authorities. Equipment/fixture supplier is responsible for obtaining State, County, and City acceptance on equipment/fixtures that are not UL or CSA approved or are not listed for installation.
- B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
- C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- D. Hazardous Materials:
 - 1. Comply with local, State of California, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
 - 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 26, Electrical Sections. In the absence of specific requirements, comply with the following:
 - 1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
 - a. Ceiling access panels to be minimum of 24-inch by 24-inch.
 - b. Wall access panels to be minimum of 12-inch by 12-inch.
 - c. Provide two keys for each set of keyed cylinder type locks.
 - d. Manufacturers and Models:
 - 1) Drywall: Karp KDW.
 - 2) Plaster: Karp DSC-214PL.
 - 3) Masonry: Karp DSC-214M.
 - 4) 2 hour rated: Karp KPF-350FR.
 - 5) Manufacturers: Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

- B. Install equipment requiring access (i.e., junction boxes, light fixtures, power supplies, motors, etc.) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in passageways, doorways, scuttles or crawlspaces which would impede or block the intended usage.
- C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.
- D. Earthwork:
 - 1. Confirm Earthwork requirements in Contract Documents. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork Sections. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
 - b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
 - c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.
- E. Firestopping:
 - 1. Confirm requirements in Division 07, Thermal and Moisture Protection. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- F. Plenums:
 - 1. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.
- G. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- H. Provide miscellaneous supports/metals required for installation of equipment and conduit.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26 Electrical Sections.
- B. Equipment Importance Factor: 1.0.
- C. General:
 - 1. Confirm Building Risk Category and Seismic Design Category with Architect.
 - 2. Earthquake resistant designs for Electrical (Division 26, Electrical) equipment and distribution, i.e. power distribution equipment, generators, UPS, etc. to conform to regulations of jurisdiction having authority.
 - 3. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment

and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.

4. Provide stamped shop drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for conduit and equipment. Submit shop drawings along with equipment submittals.
5. Provide stamped shop drawings from licensed Structural Engineer of seismic flexible joints for conduit crossing building expansion or seismic joints. Submit shop drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.

D. Equipment:

1. Provide means to prohibit excessive motion of electrical equipment during earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
 1. Underground conduit installation prior to backfilling.
 2. Prior to covering walls.
 3. Prior to ceiling cover/installation.
 4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
- C. Final Punch:
 1. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.4 CONTINUITY OF SERVICE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:
 1. During remodeling or addition to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.
 2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new wiring, and wiring to point of connection.
 3. Coordinate transfer time to new service with Owner. If required, perform transfer during off-peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
 - a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 4. No interruption of services to any part of existing facilities will be permitted without express permission in each instance from Owner. Requests for outages must state specific dates, hours and maximum durations, with outages kept to these specific dates, hours and maximum durations. Obtain written permission from Owner for any interruption of power, lighting or signal circuits and systems.
 - a. Organize work to minimize duration of power interruption.
 - b. Coordinate utility service outages with utility company.

3.5 CUTTING AND PATCHING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:

1. Proposed floor cutting/core drilling/sleeve locations to be approved by project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and/or walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

- A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

3.7 DELIVERY, STORAGE AND HANDLING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage and handling to be replaced before installation.
 2. Protect equipment to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
 3. Protect bus duct and similar items until in service.

3.8 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, and individual Division 26, Electrical Sections.
- B. Upon completion of work and adjustment of equipment, test systems and demonstrate to Owner's Representative, Architect, and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.9 CLEANING

- A. Confirm Cleaning requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Upon completion of installation, thoroughly clean electrical equipment, removing dirt, debris, dust, temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

- A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.
- C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- D. Provide miscellaneous supports/metals required for installation of equipment.

3.11 PAINTING

- A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - 1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces (i.e., hangers, hanger rods, equipment stands, etc.) with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
 - 2. In Electrical Room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
 - 3. See individual equipment Specifications for other painting.
 - 4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
 - 5. Conduit: Clean, primer coat and paint interior/exterior conduit exposed in public areas with two coats paint suitable for metallic surfaces. Color selected by Architect.
 - 6. Covers: Covers such as manholes, vaults and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

- A. Confirm Access Panel requirements in Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:
 - 1. Coordinate locations/sizes of access panels with Architect prior to work.

3.13 DEMOLITION

- A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 - 1. It is the intent of these documents to provide necessary information and adjustments to electrical system required to meet code, and accommodate installation of new work.

2. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas. Owner will cooperate to best of their ability to assist in coordinated schedule, but will remain final authority as to time of work permitted.
3. Examination:
 - a. Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to locate and preserve utilities. Replace damaged items with new material to match existing.
 - b. Verify that abandoned wiring and equipment serve only abandoned facilities.
 - c. Demolition drawings are based on casual field observation and existing record documents.
 - 1) Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish work.
 - 2) Verify location and number of electrical outlets, luminaires, panels, etc. in field.
 - d. Report discrepancies to Architect before disturbing existing installation.
 - 1) Promptly notify Owner if utilities are found which are not shown on Drawings.
4. Execution:
 - a. Remove existing luminaires, switches, receptacles, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless shown as retained or relocated on Drawings.
 - b. Provide temporary wiring and connections to maintain electrical continuity of existing systems during construction. Remove or relocate electrical boxes, conduit, wiring, equipment, and luminaires, as encountered in removed or remodeled areas in existing construction affected by this work.
 - c. Remove and restore wiring which serves usable existing outlets clear of construction or demolition.
 - d. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, provide new conduit and wire to bypass inaccessible junction boxes and abandoned outlets.
 - e. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and wire to reroute clear of construction or demolition and maintain service to existing load.
 - f. Extend circuiting and devices in existing walls to be furred out.
 - g. Remove abandoned wiring to source of supply.
 - h. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
 - i. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
 - j. Disconnect and remove abandoned panelboards and distribution equipment.
 - k. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
 - l. Repair adjacent construction and finishes damaged during demolition work.
 - m. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

3.14 ACCEPTANCE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
 1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
 - a. Cleaning
 - b. Operation and Maintenance Manuals
 - c. Training of Operating Personnel
 - d. Record Drawings
 - e. Warranty and Guaranty Certificates
 - f. Start-up/Test Document and Commissioning Reports

3.15 FIELD QUALITY CONTROL

- A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
- B. Tests:
 - 1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in operation and maintenance manuals.
 - 2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 SALVAGED EQUIPMENT AND RECYCLED MATERIAL

- A. Salvage the following equipment not being reused and return to Owner:
 - 1. Luminaires
 - 2. Panelboards
 - 3. Breakers
 - 4. Transformers
- B. Electrical equipment that cannot be salvaged for reuse sell/give to recycling company. Recycle following excess, removed, or demolished electrical material:
 - 1. Copper or aluminum conductors, buses, and motor/transformer windings.
 - 2. Steel and aluminum from raceways, boxes, enclosures, and housings.
 - 3. Acrylic and glass from luminaire lenses/refractors.
- C. Provide separate on-site storage space for recycled, recycled and salvaged, or salvaged material. Clearly label space.
- D. Confirm additional salvaged equipment and recycled materials in the Contract Documents.

END OF SECTION

SECTION 260509 EQUIPMENT WIRING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Equipment connections, whether furnished by Owner or other Divisions of the Contract.
 - 2. Equipment grounding.

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition:
 - 1. Verify mechanical and utilization equipment electrical characteristics with Drawings and equipment submittals prior to ordering equipment. Submit confirmation of this verification as a part of, or addendum to, the electrical product submittals.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials and Equipment for Equipment Wiring: As specified in individual Sections.

2.2 GENERAL

- A. Unless otherwise noted, the following voltage and phase characteristics apply to motors:
 - 1. 3/4 HP and Under: 120 volt, 1 phase.
 - 2. 1 HP and Over: 240 volt, 3 phase.
- B. Safety Switches: Provide as required by CEC and as specified in Section 26 28 16, Enclosed Switches and Circuit Breakers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to submittal of product data for electrical distribution equipment, obtain and examine product data and shop drawings for equipment furnished by the Owner and by other trades on the project. Update the schedule of equipment electrical connections accordingly, noting proper ratings for overcurrent devices, fuses, safety disconnect switches, conduit and wiring, and the like. As a minimum, this requirement applies to equipment furnished by Owner and equipment furnished under the following divisions of work under this contract:
1. Division 10, Specialties
 2. Division 11, Equipment
 3. Division 14, Conveying Equipment
 4. Division 21, Fire Suppression
 5. Division 22, Plumbing
 6. Division 23, HVAC, Heating, Ventilating and Air Conditioning
 7. Division 27, Communications
 8. Division 28, Electronic Safety and Security

3.2 INSTALLATION

- A. Do not install unrelated electrical equipment or wiring on mechanical equipment without prior approval of Engineer.
- B. Provide moisture tight equipment wiring and switches in ducts or plenums used for environmental air.
- C. Connect motor and appliance/utilization equipment complete from panel to motor/equipment as required by code.
- D. Install motor starters and controllers for equipment furnished by others.
- E. Appliance/Utilization Equipment:
1. Provide appropriate cable and cord cap for final connection unless equipment is provided with same. Provide receptacle configured to receive cord cap.
 2. Verify special purpose outlet NEMA configuration and ampere rating with equipment supplier prior to ordering wiring devices and coverplates.
- F. Door Hardware:
1. Provide dedicated circuit from nearest 208/120V emergency panelboard for door hardware power supplies. Provide complete control connections for door hardware locking mechanisms to building security system.
 2. Provide control connection for door hardware locking mechanisms to building fire alarm system.
 3. Coordinate with Division 08, Openings and Drawing requirements.
- G. Furniture Partitions:
1. Provide liquid-tight flexible connections from wall or floor outlet as shown on Drawings with pull string. Provide handle-tie breakers for simultaneous disconnecting of power by branch circuit breakers for multi-wire branch circuits. Provide connection to furniture as directed by shop drawings for owner furnished furniture partitions.
 2. Splice incoming wiring for phases, neutral and ground to the power feed connection provided for the furniture partition system so that no outlets are non-functioning at completion of work.
 3. Coordination with Division 08, Openings and Drawing requirements.
- H. ADA Automatic Doors:

1. Provide control wiring in continuous raceway from door controller unit to manual wall control stations. Provide local switch disconnect for door controller as required by Code.
 2. Coordinate with Division 08, Openings and Drawing requirements.
- I. Garbage Waste Disposal Compactor:
1. Obtain supplier's shop drawings prior to rough-in and provide complete connections per supplier's shop drawings.
 2. Provide connections to solenoid valves, blowers, and the like.
 3. Coordinate with Division 22, Plumbing and Drawing requirements.
- J. Motorized Shades and Curtains:
1. Provide control wiring between remote switch control as shown on Drawings and each shade and curtain motor per manufacturers shop drawings. Provide continuous recessed raceway for control wiring and power to shade and curtain motors. Provide local switch disconnect for each motor as required by Code.
 2. Where photosensor control option is provided, install photosensor for shades as recommended by manufacturer and connect to upstream control panel.
 3. Coordinate with Division 12, Furnishings and Drawings.
- K. ADA Wheelchair Lift:
1. Provide separate fused safety disconnect for lift.
 2. Provide telecom outlet with dedicated raceway to nearest IDF room.
 3. Coordinate with Division 14, Conveying Equipment and Drawing requirements.
- L. Freezer and Cooler Box Connections:
1. Obtain supplier's shop drawings prior to rough-in and provide complete connections per supplier's shop drawings.
 2. Provide connections to electric defrost elements, door heaters, vent heaters, door switches, lights, condensate drain heaters, blower fans, and the like.
 3. Provide control wiring as required by control systems, and install per manufacturer's instructions.
- M. Residential and Commercial dryers:
1. Provide interlocks to exhaust fan so that fan is running when dryer is in use.
 2. Coordinate with Division 11, Equipment and Drawing requirements.
- N. Smoke Control Systems, Stairwell Pressurization Fans, and Fire Pumps:
1. Provide power and control wiring utilizing a 2-hour rated cable, or encase in 2-inches (51mm) of concrete, unless one of the following three methods can be utilized in accordance with IBC Section 909:
 - a. Locate power and control wiring exterior to the building and directly connected to the smoke-proof enclosure.
 - b. Locate power and control wiring within the smoke-proof enclosure.
 - c. Locate power and control wiring within the building but separated from the remainder of the building including other mechanical equipment by not less than 2-hour fire barriers.
 2. One or more of the above installation methods may be applied if, and only if, the complete wiring route, from the connection of each fan motor to the connection at the standby power source, is separated and protected, as approved by the Local Authority Having Jurisdiction.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Division 01, General Requirements.

3.4 SYSTEMS STARTUP

- A. Provide field representative to prepare and start equipment.

1. Test and correct for proper rotation of polyphase motors.
- B. Adjust for proper operation within manufacturer's published tolerances.
- C. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION



SECTION 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Lugs and Pads
 - 2. Wires and Cables
 - 3. Splices
 - 4. Connectors

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Cable insulation test reports in project closeout documentation.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Lugs and Pads:
 - 1. Anderson .
 - 2. IlSCO
 - 3. Panduit
 - 4. Thomas & Betts
 - 5. 3M
 - 6. Or approved equivalent.
- B. Wires and Cables:

1. General
 - a. Carol
 - b. General Cable
 - c. Okonite
 - d. Southwire
 - e. Alcan/Stabiloy
 - f. Or approved equivalent.
 2. Metal Clad Cable - Type MC:
 - a. Alflec
 - b. AFC
 - c. Carol
 - d. Southwire
 - e. Or approved equivalent.
 3. Armored Cable - Type AC or Type HCF-AC:
 - a. Alflec
 - b. AFC
 - c. Carol
 - d. Southwire
 - e. Or approved equivalent.
 4. Non Metallic Sheathed Cable - NMB
 - a. Southwire
 - b. Cerro
 - c. Or approved equivalent.
- C. Splices:
1. Branch Circuit Splices:
 - a. Ideal
 - b. Scotch-Lock
 - c. 3M
 - d. Or approved equivalent.
 2. Feeder Splices:
 - a. 3M
 - b. Not allowed.
- D. Connectors:
1. Stranded conductors by Anderson.
 2. Burndy
 3. IlSCO
 4. 3M
 5. Thomas & Betts
 6. Or approved equivalent.

2.2 LUGS AND PADS

- A. Ampacity: Cross-Sectional area of pad for multiple conductor terminations to match ampere rating of panelboard bus or equipment line terminals.
- B. Copper Pads: Drilled and tapped for multiple conductor terminals.
- C. Lugs: Compression type for use with stranded branch circuit or control conductors; mechanical lugs for use with solid branch and feeder circuit conductors.

2.3 WIRES AND CABLES

- A. Copper, 600 volt rated throughout. Conductors 12 AWG and 10 AWG, solid or stranded. Conductors 8 AWG and larger, stranded. 12 AWG minimum conductor size. Minimum insulation rating of 90 degrees C. Insulation Type: THWN-2, XHHW-2 or THHN-2.
- B. Phase color to be consistent at feeder terminations; A-B-C, top to bottom, left to right, front to back.
- C. Color Code Conductors as Follows:

PHASE	240 VOLT DELTA
A	Black
B	Orange (High Leg)
C	Blue
Neutral	White
Ground	Green
Isolated Ground	N/A

- D. MC Cable: High strength galvanized steel flexible armor. Full length minimum size No. 12 copper ground wire, THHN 90C conductors, full length tape marker phase/circuit identification on cable armor. Overall green finish on HCF-MC type cable. Short circuit throat insulators, mechanical compression termination.
- E. AC Cable (Armored Cable): Continuous corrugated aluminum armor, black. PVC jacket, with grounding conductor, XHHW-2 90 degrees C conductors, full length tape marker on jacket.
- F. NMB Cable: Not allowed.
- G. SO Cord: Annealed copper conductors, 600 volt rated. Minimum size No. 12 AWG with ground wire. Maximum of six conductors and ground per cable. 90 degrees C rated thermoset jacket.

2.4 SPLICES

- A. Feeders: Compression barrel splice with two layers Scotch 23 and four layers Scotch 33+ as vapor barrier.

2.5 CONNECTORS

- A. Split bolt connectors not allowed.
- B. Conductor Branch Circuits: Wire nuts with integral spring connectors for conductors 12 AWG through 8 AWG. Push-in type connectors where conductors are not required to be twisted together are not acceptable.
- C. Fluorescent Luminaire Disconnect: polycarbonate housing, tin-plated brass contacts, insulated 18 AWG, factory-installed solid copper leads, 105C temperature rating, UL94-V2 flammability, 4A, 600V. NEC Article 410 compliant. Finger-safe line side. Push-and-click connector.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install per manufacturer instructions, and the CEC
- B. Field Quality Control:
 - 1. Test conductor insulation on feeders of 100 amp and greater for conformity with 1000 volt megohmmeter. Use Insulated Cable Engineers Association testing procedures. Minimum

insulation resistance acceptable is 1 megohm for systems 600 volts and below. Notify Architect if insulation resistance is less than 1 megohm.

2. Test Report: Prepare a typed tabular report indicating the testing instrument, the feeder tested, amperage rating of the feeder, insulation type, voltage, the approximate length of the feeder, conduit type, and the measured resistance of the megohmmeter test. Submit test reports with project closeout documents.
3. Inspect and test in accordance with NETA Standard ATS, except Section 4.
4. Perform inspections and tests listed in NETA Standard ATS, Section 7.3.2.

3.2 LUGS AND PADS

- A. Thoroughly clean surfaces to remove all dirt, oil, grease or paint.
- B. Use torque wrench to tighten per manufacturer's directions.

3.3 WIRES AND CABLES

A. General:

1. Do not install or handle thermoplastic insulated wire and cable in temperatures below +14 degrees F (-10 C).
2. Install conductors in raceways having adequate, code size cross-sectional area for wires indicated.
3. Install conductors with care to avoid damage to insulation.
4. Do not apply greater tension on conductors than recommended by manufacturer during installation.
5. Use of pulling compounds is permitted. Clean residue from exposed conductors and raceway entrances after conductor installation. Do not use pulling compounds for installation of conductors connected to GFCI circuit breakers or GFCI receptacles.
6. Conductor Size and Quantity:
 - a. Install no conductors smaller than 12 AWG unless otherwise shown.
 - b. Provide required conductors for a fully operable system.
7. Provide dedicated neutrals (one neutral conductor for each phase conductor) in all 120V circuits
8. Conductors in Cabinets:
 - a. Cable and tree wires in panels and cabinets for power and control. Use plastic ties in panels and cabinets.
 - b. Tie and bundle feeder conductors in wireways of panelboards.
 - c. Hold conductors away from sharp metal edges.
9. Homeruns:
 - a. Do not change intent of branch circuit homeruns without approval. Homeruns for 20A branch circuits may be combined to a maximum of six current carrying conductors including neutral conductors in homeruns. Apply derating factors as required per NEC. Increase conductor size as needed.
10. Identify wire and cable under the provisions of Section 26 05 53, Identification for Electrical Systems. Identify each conductor with its panel and circuit number as indicated.
11. Exposed cable is not allowed.
12. Exposed cable must be run parallel or perpendicular to building lines and hidden from view when possible.
13. Use of MC Cable is limited to the following conditions. Installations that do not comply with the following conditions are to be removed and replaced with no additional expense to the Owner.
 - △ a. 20 and 30 amp branch wiring where following conditions apply:
 - △ 1) Where there is a suspended ceiling with accessible space above (example: suspended acousting ceiling tile).
 - △ 2) For drops to ceiling mounted luminaires in areas with accessible ceiling space.
 - △ 3) Do not use for homeruns from branch circuit panel to first device or luminaire in circuit.

- △ 4) Do not use in walls where MC cable cannot be fished into the walls after construction is completed. For example: walls with glazing or solid beams overhead, partial height walls, etc.
 - △ 5) No single run of MC cable longer than 50-feet.
 - △ 6) Use in crawl spaces to be fastened to floor joists.
 - △ 7) Use in attic spaces to be fastened to roof joists.
14. Use of AC Cable is limited to the following conditions. Installations that do not comply with the following conditions are to be removed and replaced with no additional expense to the Owner.
- a. 20 and 30 amp branch wiring where following conditions apply:
 - 1) Where there is a suspended ceiling with accessible space above (example: suspended acoustic ceiling tile).
 - 2) For drops to ceiling mounted luminaires in areas with accessible ceiling space.
 - 3) In residential units where allowed by the NEC.
 - 4) Do not use for homeruns from branch circuit panel to first device or luminaire in circuit.
 - 5) Do not use in walls in areas where AC cable cannot be fished into the walls after construction is completed. For example: walls with glazing or solid beams overhead, partial height walls, etc.
 - 6) No single run of AC cable longer than 50-feet.

3.4 SPLICES

- A. Make up splices complete and promptly after wire installation. Provide single wire pigtails for luminaire and device connections. Wirenuts may be used for luminaire wire connections to single wire circuit conductor pigtails.
- B. Make splices for No. 8 and larger wires with mechanically applied pressure type connectors. Make all taped joints with Scotch 33+ or equal, applied in half-lap layers without stretching to deform.
- C. Remove insulation with a stripping tool designed specifically for that purpose. A pocket knife is not an acceptable tool. Leave all conductors nick-free.

3.5 CONNECTORS

- A. Install to assure a solid and safe connection.
- B. Do not connect copper and aluminum wiring without UL listed connectors that are listed for the purposes.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Grounding Electrodes
 - 2. Connectors and Accessories
 - 3. Grounding Busbar
 - 4. Grounding Conductor

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Test reports of ground resistance for service and separately derived system grounds.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Comply with the requirements of ANSI/NFPA 70.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Grounding Electrodes:
 - 1. Erico
 - 2. Thomas & Betts
 - 3. Talley
 - 4. Or approved equivalent.
- B. Connectors and Accessories:
 - 1. Burndy Hyground Compression System
 - 2. Erico/Cadweld

3. Amp Ampact Grounding System
4. Pipe Grounding Clamp:
 - a. Burndy GAR Series
 - b. O Z Gedney
 - c. Thomas & Betts
 - d. Or approved equivalent.
- C. Grounding Busbar:
 1. Chatsworth
 2. Erico
 3. Schneider Electric/Square D
 4. Panduit
 5. Or approved equivalent.
- D. Grounding Conductor
 1. Carol
 2. General Cable
 3. Okonite
 4. Southwire
 5. Or approved equivalent

2.2 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, minimum 3/4-inch diameter, 10-feet long, tapered point, chamfered top.

2.3 CONNECTORS AND ACCESSORIES

- A. Grounding Connectors: Hydraulic compression tool applied connectors or exothermic welding process connectors or powder actuated compression tool applied connectors.
- B. Pipe Grounding Clamp: Mechanical ground connector with cable parallel or perpendicular to pipe.

2.4 GROUNDING BUSBAR

- A. Grounding Busbar: 1/4-inch thick by 4-inch high by 10-inch long copper grounding busbar with insulators that meet ANSI J-STD-607-A specifications. UL 467 listed. Hole patterns in busbar to accommodate two-hole lugs, four-hole configuration.

2.5 GROUNDING CONDUCTOR

- A. Grounding Electrode Conductor: Soft-draw bare stranded copper for wire sizes larger than #10 AWG Bare. Solid copper for wire sizes #10 AWG and smaller.
- B. Equipment Grounding Conductor: Green insulated, insulation type to match that of associated feeder or branch circuit wiring, size as indicated on drawings.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Verify site conditions prior to beginning work.
- B. Bond Sections of service equipment enclosure to service ground bus.
- C. Separately Derived Systems: Ground each separately derived system per NEC Article 250.
- D. Bond together reinforcing steel and metal accessories in fountain structures.

- E. Corrosion inhibitors: Apply a corrosion inhibitor to contact surfaces when making grounding and bonding connections. Use corrosion inhibitor appropriate for protecting a connection between metals used.
- F. Grounding system resistance to ground not to exceed 5 ohms. Make necessary modifications or additions to grounding electrode system for compliance. Submit final tests to assure that this requirement is met.
- G. Resistance of grounding electrode system: measure using a four-terminal fall-of-potential method as defined in IEEE 81. Take ground resistance measurements before electrical distribution system is energized and in normally dry conditions, not less than 48 hours after last rainfall. Take resistance measurements of separate grounding electrode systems before systems are bonded together below grade. Combined resistance of separate systems may be used to meet required resistance, but specified number of electrodes must still be provided.
- H. Inspect and test in accordance with NETA Standard ATS, Except Section 4.
- I. Perform inspections and tests listed in NETA Standard AB, Section 7.13.

3.2 GROUNDING ELECTRODES INSTALLATION

- A. Ground Rod Electrode:
 - 1. Verify that final backfill and compaction have been completed before driving rod electrodes.
 - 2. Bond #6 grounding electrode conductor to driven ground rods as indicated on Drawings.
 - 3. Tap at center ground rod and extend grounding electrode conductor to service grounding bus. Install grounding electrode conductor to service grounding bus in rigid PVC conduit for physical protection where grounding electrode conductor passes through concrete floor or other concrete structure.
- B. Metal Underground Water Service: Bond water service pipe to service equipment ground bus or to the grounding electrode system. Connect to water pipe on utility side of isolating fittings or meters, bond across water meters.
- C. Other Metal Piping Systems: Bond gas piping system, fire sprinkler piping system and other metal piping systems to service equipment ground bus or to the grounding electrode system.
- D. Bond together metal siding not attached to grounded structure; bond to grounding electrode system.

3.3 CONNECTORS AND ACCESSORIES INSTALLATION

- A. Install per manufacturer's instructions.

3.4 GROUNDING BUSBAR INSTALLATION

- A. Install per manufacturer's instructions.

3.5 GROUNDING CONDUCTOR INSTALLATION

- A. Raceways:
 - 1. Ground metallic raceway systems. Bond to ground terminal with code size jumper except where code size or larger equipment grounding conductor is included with circuit, use grounding bushing with lay-in lug.
 - 2. Connect metal raceways, which terminate within an enclosure but without mechanical connection to enclosure, by grounding bushings and ground conductor to grounding bus.
 - 3. Where equipment supply conductors are in flexible metallic conduit, install stranded copper equipment grounding conductor from outlet box to equipment frame.
 - 4. Install equipment grounding conductor, code size minimum unless noted on drawings, in metallic and nonmetallic raceway systems.

- B. Feeders and Branch Circuits:
1. Provide continuous green insulated copper equipment grounding conductors for feeders and branch circuits.
 2. Where installed in a continuous solid metallic raceway system and larger sizes are not detailed, provide insulated equipment grounding conductors for feeders and branch circuits sized in accordance with the latest adopted edition of NEC Article 250, Table 250-122.
- C. Bond boxes, cabinets, enclosures and panelboard equipment grounding conductors to enclosure with specified conductors and lugs. Install lugs only on thoroughly cleaned contact surfaces.
- D. Motors, Equipment and Appliances: Install code size equipment grounding conductor to (motor) equipment frame or manufacturer's designated ground terminal.
- E. Receptacles: Connect ground terminal of receptacle and associated outlet box to equipment grounding conductor. Self grounding nature of receptacle devices does not eliminate equipment grounding conductor bolted to outlet box.
- F. Bond electrostatic discharge (ESD) flooring integral grounding conductor to electrically grounded connectors or structures at two opposite locations, in the area of the ESD flooring installation.

END OF SECTION



SECTION 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Anchors, Threaded Rod and Fasteners
 - 2. Support Channel, Hangars and Supports
 - 3. Rooftop Conduit Supports

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. Submittals not required for this Section.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.
 - 2. Support systems to be supplied by a single manufacturer.
 - 3. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, equipment hangers/supports, and seismic restraint by a qualified ~~Structural Professional Engineer.~~
 - ~~△ a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.~~

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.7 PERFORMANCE REQUIREMENTS

- A. General: Provide conduit and equipment hangers and supports in accordance with the following:

1. When supports, anchorages, and seismic restraints for equipment and supports, anchorages and seismic restraints for conduit, cable tray and equipment are not shown on the Drawings, the Contractor is responsible for their design.
 2. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
- B. Engineered Support Systems: The following support systems to be designed, detailed, and bear the seal of a professional engineer registered in the State of California.
1. Support frames such as conduit racks or stanchions for conduit and equipment which provide support from below.
 2. Equipment and piping support frame anchorage to supporting slab or structure.
- C. Provide channel support systems, for conduits to support multiple conduits capable of supporting combined weight of support systems and system contents.
- D. Provide heavy-duty steel trapezes for piping to support multiple conduit capable of supporting combined weight of supported systems and system contents.
- E. Provide seismic restraint hangers and supports for conduit and equipment.
- F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Anchors, Threaded Rod and Fasteners:
1. Anchor It
 2. Epcon System
 3. Hilti-Hit System
 4. Power Fast System
 5. Or approved equivalent.
- B. Support Channel, Hangars and Supports:
1. B-Line
 2. Kindorf
 3. Superstrut
 4. Unistrut
 5. Or approved equivalent.
- C. Rooftop Conduit Supports:
1. Cooper B-Line Dura-Block Rooftop Support Base
 2. Or approved equivalent.

2.2 ANCHORS, THREADED ROD AND FASTENERS:

- A. Anchors, Threaded Rod and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Concrete Inserts: Cast in concrete for support fasteners for loads up to 800 lbs.
- C. Anchor Bolts for Area Luminaire Poles: As supplied by area luminaire pole manufacturer.
- D. Anchors and Fasteners:

1. Do not use powder-actuated anchors.
 2. Obtain permission from Architect before using powder-actuated anchors.
 3. Concrete Structural Elements: Use precast inserts.
 4. Steel Structural Elements: Use beam clamps.
 5. Concrete Surfaces: Use self-drilling anchors.
 6. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
 7. Solid Masonry Walls: Use expansion anchors.
 8. Sheet Metal: Use sheet metal screws.
 9. Wood Elements: Use wood screws.
- E. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.
- F. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.
- G. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

2.3 SUPPORT CHANNEL, HANGARS AND SUPPORTS:

- A. Hangers and Supports - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
1. Channel Material: Carbon steel.
 2. Coating: Hot dip galvanized.
- B. Pipe Straps: Two-hole galvanized or malleable iron.
- C. Luminaire Chain: 90 lb. test with steel hooks.
- D. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on Drawings or otherwise not shown on drawings that are necessary for completion of the project. The Contractor is responsible for their design.
1. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.
- E. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.
- F. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.
- G. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

2.4 ROOFTOP CONDUIT SUPPORTS:

- A. Curb base made of 100 percent recycled rubber and polyurethane prepolymer with a uniform load
- B. Capacity of 500 pounds per linear foot of support.

- C. UV resistant.
- D. Steel Frame: Steel, 14 gauge strut galvanized per ASTM A653 or 12 gauge strut galvanized per ASTM A653 for bridge series.
- E. Continuous block channel supports with 1-inch gaps to allow water flow, bridge channel supports, extendable height channel supports and elevated single conduit supports.
- F. Attaching Hardware: Zinc-plated threaded rod, nuts and attaching hardware per ASTM B633 fastened directly into rubber material with weather resistant Type 12 lag screws.
- G. Provide load distribution plates when required for heavy loads.
- H. Finish: Black with safety yellow striping.
- I. Provide hot dipped galvanized components for items exposed to weather.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Fabrication - Miscellaneous Metals
 - 1. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on Drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.
 - 2. Finishes:
 - a. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with one coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
 - b. Metal in contact with Concrete, Masonry and Other Dissimilar Materials: Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
 - c. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

3.2 ANCHORS, THREADED ROD AND FASTENERS INSTALLATION:

- A. Safety factor of 4 required for every fastening device or support for electrical equipment installed. Supports to withstand four times the weight of equipment it supports.
- B. Do not use other trade's fastening devices as supporting means for electrical luminaires, equipment or materials.
- C. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

- D. Do not use supports or fastening devices to support other than one particular item.
- E. Securely suspend junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from floor above or roof structure to prevent sagging and swaying.
- F. Provide seismic bracing per CBC requirements.
- G. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- H. Use spring lock washers under fastener nuts for strut.
- I. Cutting and Drilling
 - 1. Do not drill or cut structural members without prior permission from Architect.

3.3 SUPPORT CHANNEL, HANGARS AND SUPPORTS INSTALLATION:

- A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
- B. Safety factor of 4 required for every fastening device or support for electrical equipment installed. Supports to withstand four times the weight of equipment it supports.
- C. Verify mounting height of luminaires prior to installation when heights are not detailed.
- D. Install vertical support members for equipment and luminaires, straight and parallel to building walls.
- E. Install horizontal support members straight and parallel to ceilings or finished floor unless otherwise noted.
- F. Provide independent supports to structural member for electrical luminaires, materials, or equipment installed in or on ceiling, walls or in void spaces or over suspended ceilings.
- G. Do not use other trade's fastening devices as supporting means for electrical luminaires, equipment or materials.
- H. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- I. Do not use supports or fastening devices to support other than one particular item.
- J. Support conduits within 18-inches of outlets, boxes, panels, cabinets and deflections unless more stringently required by CEC.
- K. Maximum distance between supports not to exceed 8 foot spacing unless otherwise required by CEC.
- L. Support flexible conduits and metal clad cable within 12-inches of outlets, boxes, panels, cabinets and deflections unless otherwise required by CEC.
- M. Maximum distance between supports for flexible conduits and metal clad cable not to exceed 48-inches spacing unless otherwise required by CEC.
- N. Maximum distance between supports for rigid PVC conduits unless otherwise required by CEC is as follows:
 - 1. 1/2-inch or 3/4-inch and 1-inch conduit, 3-feet apart.
 - 2. 1-1/4-inch or 1-1/2-inch and 2-inch conduit, 4-feet apart.
 - 3. 2-1/2-inch and 3-inch conduit, 5-feet apart.
 - 4. 4-inch and 5-inch conduit, 6-feet apart.
 - 5. 6-inch conduit, 7-feet apart.

- O. Maximum distance between supports for auxiliary gutters and wireways unless otherwise required by CEC is as follows:
 - 1. Sheet metal auxiliary gutters and wireways - 4-feet apart horizontally and 10-feet vertically.
 - 2. Non-metallic auxiliary gutters and wireways - 30-inches apart horizontally and 3-feet vertically.
- P. Install strut hangers as instructed by strut manufacturer. Suspended strut hangers as instructed by strut manufacturer for the load, with a maximum spacing of 8-feet on center and within 2-feet of outlet box, cabinet, junction box or other channel raceway termination unless otherwise required by CEC.
- Q. Coordinate routing of conduit racks with materials and equipment installed by other trades. Where conduit racks are exposed to view, coordinate location and installation with Architect for optimal appearance.
- R. Securely suspend junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from floor above or roof structure to prevent sagging and swaying.
- S. Provide seismic bracing per CBC requirements.
- T. Where service disconnects are mounted on building exterior, physically attach service disconnect to the building or structure served.
- U. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- V. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- W. Wet and Damp Locations:
 - 1. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1-inch off wall.

3.4 ROOFTOP CONDUIT SUPPORTS INSTALLATION:

- A. Consult roofing manufacturer for roof membrane compression capacities. If necessary, provide a compatible sheet of roofing material (rubber pad) under rooftop support to disperse concentrated loads and add further membrane protection.
- B. Do not use supports that will void roof warranty.
- C. Install supports per manufacturers instructions and recommendations.
- D. Use properly sized clamps to suit conduit sizes.
- E. Install supports for rooftop raceways to raise raceways a minimum of 4-inches above the roof structure unless otherwise noted.

END OF SECTION

SECTION 260533 RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Rigid Metal Conduit (RMC)
 - 2. Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Metal Conduit
 - 3. Electrical Metallic Tubing (EMT)
 - 4. Flexible Metal Conduit (FMC)
 - 5. Liquidtight Flexible Metal Conduit (LFMC)
 - 6. Electrical Polyvinyl Chloride (PVC) Conduit
 - 7. Conduit Fittings
- B. Provide a complete system of conduit and fittings, with associated couplings, connectors, and fittings, as shown on drawings and described in these specifications.

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Section 26 05 29, Hangers and Supports for Electrical Systems and Equipment
 - 2. Section 26 05 34, Boxes

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals not required for this Section.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.7 DEFINITIONS

- A. Raceway system is defined as consisting of conduit, tubing, duct, and fittings including but not limited to connectors, couplings, offsets, elbows, bushings, expansion/deflection fittings, and other components and accessories. Complete electrical raceway installation before starting the installation of conductors and cables.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Rigid Metal Conduit (RMC):
 - 1. Allied Tube & Conduit
 - 2. Beck Manufacturing Inc.
 - 3. Picoma
 - 4. Wheatland Tube Company
 - 5. Or approved equivalent.

- B. Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit:
 - 1. Allied Tube & Conduit
 - 2. Thomas & Betts Corporation
 - 3. Robroy Industries
 - 4. Or approved equivalent.

- C. Electrical Metallic Tubing (EMT):
 - 1. Allied Tube & Conduit
 - 2. Beck Manufacturing WL
 - 3. Picoma
 - 4. Wheatland Tube Company
 - 5. Or approved equivalent.

- D. Flexible Metal Conduit (FMC):
 - 1. AFC Cable Systems Inc.
 - 2. Electri-Flex Company
 - 3. International Metal Hose
 - 4. Or approved equivalent.

- E. Liquidtight Flexible Metal Conduit (LFMC):
 - 1. AFC Cable Systems Inc.
 - 2. Electri-Flex Company
 - 3. International Metal Hose
 - 4. Or approved equivalent.

- F. Electrical Polyvinyl Chloride (PVC) Conduit:
 - 1. AFC Cable Systems Inc.
 - 2. Electri-Flex Company
 - 3. International Metal Hose
 - 4. JM Eagle
 - 5. Or approved equivalent.

- G. Conduit Fittings:
 - 1. Bushings:
 - a. Insulated type for Threaded Rigid, IMC, or EMT without Factory Installed Plastic Throat Conductor Protection:
 - 1) Thomas & Betts 1222 Series
 - 2) O-Z Gedney B Series
 - 3) Or approved Equivalent.
 - 2. Raceway Connectors and EMT Couplings:
 - a. Thomas & Betts Series
 - b. O-Z Gedney Series

- c. Or approved Equivalent.
- 3. Expansion/Deflection Fittings:
 - a. EMT, O-Z Gedney Type TX
 - b. RMC, O-Z Gedney Type AX, DX and AXDX, Crouse & Hinds XD
 - c. Or approved equivalent.

2.2 RIGID METAL CONDUIT (RMC)

- A. UL 6, ANSI C80.1. Hot dipped galvanized steel conduit after thread cutting.
 - 1. Fittings: NEMA FB2.10.

2.3 POLYVINYL CHLORIDE (PVC) EXTERNALLY COATED GALVANIZED RIGID METAL CONDUIT

- A. Description: NEMA RN 1; rigid steel conduit with external PVC coating.
- B. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.4 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: UL 797, ANSI C80.3; steel galvanized tubing.
- B. Fittings: NEMA FB 1; steel, compression type.

2.5 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: UL 1, Interlocked steel construction.
- B. Fittings: NEMA FB 2.20.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: UL 360, inner core made from spiral wound strip of heavy gauge, hot dipped galvanized low carbon steel. 1/2-inch through 1-1/4-inch trade sizes have a square lock core and contain an integral bonding strip of copper. 1-1/2-inch and larger have fully interlocked core. Jacket material is moisture, oil and sunlight resistant flexible PVC.
- B. Fittings: NEMA FB 2.20.

2.7 ELECTRICAL POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: UL 651, NEMA TC 2; Schedule 40 PVC.
- B. Fittings: NEMA TC 3.

2.8 CONDUIT FITTINGS

- A. Bushings:
 - 1. Insulated type for threaded rigid IMC conduit without factory installed plastic throat conductor protection.
 - 2. Insulated grounding type for threaded rigid IMC conduit.
- B. Raceway Connectors and EMT Couplings:
 - 1. Steel connectors, couplings, and conduit bodies, with hot-dip galvanized.
 - 2. Connector locknuts are steel, with threads meeting ASTM tolerances. Locknuts are hot-dip galvanized.
 - 3. Connector throats (EMT, flexible conduit, metal clad cable and cordset connectors) have factory installed plastic inserts permanently installed. For normal cable or conductor exiting angles from raceway, the cable jacket or conductor insulation bears only on plastic throat insert.

4. Steel gland, Tomic or Breagle connectors and couplings are recognized for this Contract as having acceptable raceway to fitting electrical conductance.
 5. Set screw connectors and couplings, without integral compression glands, are recognized for this contract as not having acceptable raceway to fitting electrical conductance. A ground conductor sized per this Specification must be included and bonded within raceway assembly utilizing this type connector or coupling.
- C. Provide expansion/deflection fittings for EMT.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Finished Surfaces: Schedule raceway installation to avoid conflict with installed wall and ceiling surfaces. If unavoidable, coordinate work and repairs with Architect.
- B. Conduit Size:
1. Minimum Size: 1/2-inch for power and control, unless otherwise noted. 3/4-inch for communication/data, unless otherwise noted. 1/2-inch for signal systems, unless otherwise noted.
- C. Underground Installations:
1. More than 5-feet from Foundation Wall: Use PVC.
 2. Within 5-feet from Foundation Wall: Use PVC coated RMC.
 3. In or Under Slab on Grade: Use PVC.
 4. Minimum Size: 1-inch.
- D. In Slab Above Grade:
1. Use PVC.
 2. Maximum Size Conduit in Slab: Contact Structural Engineer for maximum outside diameter of conduit.
- E. Provide two pull strings/tapes in empty conduits. Types:
1. Utility Company Conduit: Polyester measure/pulling tape, Greenlee 4436 or approved equivalent. Coordinate exact requirements with utility company.
 2. Feeders: Polyester measure/pulling tape, Greenlee 4436 or approved.
 3. Branch circuits and low voltage: Greenlee Poly Line 431 or approved.
 4. If fish tape is used for pulling line or low voltage wiring, fiberglass type to be used. Metal fish tapes will not be allowed.
 5. Secure pull string/tape at each end.
 6. Provide caps on ends of empty conduit to be used in future.
 7. Label both ends of empty conduits with location of opposite end.
- F. Elbows: Fiberglass or PVC coated RMC acceptable for underground installations.
- G. Elbow for Low Energy Signal Systems: Use long radius factory ells where linking sections of raceway for installation of signal cable.
- H. Verify that field measurements are as shown on drawings.
- I. Plan locations of conduit runs in advance of the installation and coordinate with ductwork, plumbing, ceiling and wall construction in the same areas.
- J. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, and walls. Penetrations are acceptable only when the following occurs:
1. Where shown on the structural drawings.

2. As approved by the Structural Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
- K. Verify routing and termination locations of conduit prior to rough-in.
 - L. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.
 - M. Install raceways securely, in neat and workmanlike manner, as specified in NECA 1, Standard Practices for Good Workmanship in Electrical Construction.
 - N. Install steel conduit as specified in NECA 101, Standard for Installing Steel Conduits.
 - O. Install nonmetallic conduit in accordance with manufacturer's instructions.
 - P. Inserts, anchors and sleeves.
 1. Coordinate location of inserts and anchor bolts for electrical systems prior to concrete pour.
 2. Coordinate location of sleeves with consideration for other building systems prior to concrete pour.
 - Q. Conduit Supports:
 1. Arrange supports to prevent misalignment during wiring installation.
 2. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
 3. Group related conduits; support using conduit rack. Construct rack using steel channel. Provide space on each for 25 percent additional conduits.
 4. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
 5. Do not attach conduit to ceiling support wires.
 - R. Flexible steel conduit length not-to-exceed 6-feet, 3-feet in concealed walls. Provide sufficient slack to reduce the effect of vibration.
 - S. Install conduit seals at boundaries where ambient temperatures differ by 10 degrees F or more as shown on the drawings. Install seals on warm side of partition.
 - T. Seal raceways stubbing up into electrical equipment. Plug raceways with conductors with duct-seal. Cap spare raceways and plug PVC raceway products with plastic plugs as made by Underground Products, or equal, shaped to fit snugly into the stubup.
 - U. Seal raceways penetrating an exterior building wall to prevent moisture and vermin from entering into the electrical equipment.
 - V. Use suitable caps on spare and empty conduits to protect installed conduit against entrance of dirt and moisture.
 - W. Keep emergency system wiring independent of other wiring systems per NEC 700.
 - X. Installation of conduit in structural concrete that is less than 3-inches thick is prohibited without the approval of the Structural Engineer. Maintenance pads, and curbs are exempted.
 - Y. Raceways Embedded in Floor Slabs:
 1. Do not install raceways in slab without the approval of the Structural Engineer.
 2. Do not let raceways interfere with placement of floor slab reinforcement components.
 3. Install raceways between the upper and the lower layers of reinforcing steel.
 4. Space raceways not less than 8-inches on centers except where they converge at panels or junction boxes.
 5. Raceways running parallel to slabs supports, such as beams, columns and structural walls, to be installed not less than 12-inches from such supporting elements.

6. Branch circuit homeruns are not permitted in slab, route branch circuit homeruns above grade exposed in approved areas or above lay-in ceiling spaces.
 7. Route conduits in or under slabs point-to-point.
 8. Do not cross conduits in slab.
 9. Encase medium voltage feeder conduits using red concrete.
- Z. Arrange conduit to maintain headroom and present neat appearance.
- AA. Do not install conduits on surface of building exterior, along vapor barrier, across roof, on top of parapet walls, or across floors, unless otherwise noted on drawings.
- AB. Exposed conduits are permitted only in following areas:
1. Mechanical rooms, electrical rooms or spaces where walls, ceilings and floors will not be covered with finished material.
 2. Existing walls that are concrete or block construction.
 3. Where specifically noted on Drawings.
 4. Route exposed conduit parallel and perpendicular to walls, tight to finished surfaces and neatly offset into boxes.
- AC. Do not install conduits or other electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block area passage's intended usage.
- AD. Install continuous conduit and raceways for electrical power wiring and signal systems wiring.
- AE. Below Grade Conduit:
1. Place minimum 3-inch cover of sand or clean earth fill around conduit. Lay conduit on smooth level trench bottom, so that contact is made for its entire length.
 2. Remove water from trench before conduit is installed.
 3. When three or more conduits are in a single trench, use conduit spacers that will maintain 3-inch spacing between conduits. Provide spacers on 5-foot centers.
 4. Provide PVC coated galvanized rigid conduit for elbows larger than 30 degrees or 1-inch diameter.
 5. Provide trenching, backfilling, compaction, repaving or other site restoration as required by work done in this division.
 6. Slope underground conduits which enter building to drain away from building and to be water sealed to prevent moisture from passing through conduit into building. Joints threaded and taped or glued to prevent entry of water into conduits.
 7. Provide watertight conduit sleeves and rubber seals for conduit entering building below grade, Link-Seal system by Thunderline Corporation or approved equivalent.
- AF. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
- AG. Maintain adequate clearance between conduit and piping.
- AH. Keep conduits a minimum of 12-inches away from steam or hot water radiant heating lines (at or above 104 degrees F) or 3-inches away from waste or water lines.
- AI. Cut conduit square using saw or pipecutter; deburr cut ends.
- AJ. Bring conduit to shoulder of fittings; fasten securely.
- AK. Use conduit hubs to fasten conduit to cast boxes in damp and wet locations.
- AL. Install no more than the equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate factory elbows for bends in metal conduit larger than 2-inch size.
- AM. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

- AN. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.
- AO. Conduit Terminations for Signal Systems: Provide a plastic bushing on the end of conduit used for signal system wiring.
- AP. Feeders: Do not combine or change feeder runs.
- AQ. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.
- AR. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation and installer.

3.2 RIGID METAL CONDUIT (RMC) INSTALLATION

- A. Outdoor Locations Above Grade: Use RMC.
- B. Damp Locations: RMC up to 2-inches in diameter.
- C. Dry Locations:
 - 1. Concealed: RMC.
 - 2. Exposed: RMC.
- D. Dry, Protected: RMC.
- E. In areas exposed to severe mechanical damage: RMC.
- F. For security conduits installed exposed and subject to tampering: RMC.
- G. In hazardous areas per CEC 501: RMC.

3.3 POLYVINYL CHLORIDE (PVC) EXTERNALLY COATED GALVANIZED RIGID METAL CONDUIT INSTALLATION

- A. Use PVC coated RMC 36-inch radius ells for power service conduits and 48-inch radius ells for telephone service conduits.

3.4 ELECTRICAL METALLIC TUBING (EMT) INSTALLATION

- A. Damp Locations: EMT up to 2-inches in diameter.
- B. Dry Locations:
 - 1. Concealed: EMT.
 - 2. Exposed: EMT.
- C. Dry, Protected: EMT.

3.5 FLEXIBLE METAL CONDUIT (FMC) INSTALLATION

- A. For Dry Areas: Motors, recessed luminaires and equipment connections subject to movement or vibration, use flexible metallic conduit.
- B. Flexible Conduit: Install 12-inch minimum slack loop on flexible metallic conduit.

3.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) INSTALLATION

- A. Motors and equipment connections subject to movement or vibration and subjected to any of following conditions; exterior location, moist or humid atmosphere, water spray, oil, or grease use PVC coated liquidtight flexible metallic conduit.

- B. Flexible Conduit: Install 12-inch minimum slack loop on liquidtight flexible metallic conduit.

3.7 ELECTRICAL POLYVINYL CHLORIDE (PVC) CONDUIT INSTALLATION

- A. Underground Installation: Emergency System (Life Safety and Critical) per NEC 517.30(c)(1): Schedule 80 PVC.

3.8 CONDUIT FITTINGS INSTALLATION

- A. Conduit Joints: Assemble conduits continuous and secure to boxes, panels, luminaires and equipment with fittings to maintain continuity. Provide watertight joints where embedded in concrete, below grade or in damp locations. Seal PVC conduit joints with solvent cement and metal conduit with metal thread primer. Rigid conduit connections to be threaded, clean and tight (metal to metal). Threadless connections are not permitted for RMC and IMC. Seal conduits where penetrating below raised floor area.
- B. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- C. Use set screw type fittings only in dry locations. When set screw fittings are utilized provide insulated continuous equipment ground conductor in conduit, from overcurrent protection device to outlet.
- D. Use compression fittings in dry locations, damp and rain-exposed locations. Maximum size permitted in damp locations and locations exposed to rain is 2-inches in diameter.
- E. Use threaded type fittings in wet locations, hazardous locations, and damp or rain-exposed locations where conduit size is greater than 2-inches.
- F. Use PVC coated RMC 36-inch radius ells for power service conduits and 48-inch radius ells for telephone service conduits.
- G. Use insulated type bushings with ground provision at switchboards, panelboards, safety disconnect switches, junction boxes that have feeders 60 amperes and greater.
- H. Condulets and Conduit Bodies:
 - 1. Do not use condulets and conduit bodies in conduits for signal wiring, in feeders 100 amp and larger, or for conductor splicing.
- I. Sleeves and Chases - Floor, Ceiling and Wall Penetrations: Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceilings or walls.
- J. Expansion Joints:
 - 1. Provide conduits crossing expansion joints where cast in concrete with expansion-deflection fittings, equivalent to OZ/Gedney AXDX, installed per manufacturers recommendations.
 - 2. Secure conduits 3-inches and larger to building structure on opposite sides of a building expansion joint with an expansion-deflection fitting across joint installed per manufacturer's recommendations.
 - 3. Provide conduits less than 3-inches where not cast in concrete with junction boxes securely fastened on both sides of expansion joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits 3-inch and larger may be installed.
 - 4. Verify expansion/deflection requirements with Structural Engineer prior to installation.
- K. Seismic Joints:
 - 1. No conduits cast in concrete allowed to cross seismic joint.

2. Provide conduits with junction boxes securely fastened on both sides of seismic joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. Prior to installation, verify with Architect that 15-inches is adequate for designed movement, and if not, increase this length as required.
 3. Provide conduits less than 3-inches where not cast in concrete with junction boxes securely fastened on both sides of expansion joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits 3-inch and larger may be installed.
- L. Provide rigid conduit coupling flush with surface of slab or wall for conduit stubbed in concrete slab or wall to serve electrical equipment or an outlet under table or to supply shop tool, etc. Provide plug where conduit is to be used in future.

END OF SECTION

SECTION 260534 BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Outlet Boxes
 - 2. Pull and Junction Boxes
 - 3. Box Extension Adapter
 - 4. Conduit Fittings
 - 5. Weatherproof Outlet Boxes
- B. Provide electrical boxes and fittings for a complete installation. Include but not limited to outlet boxes, junction boxes, pull boxes, bushings, locknuts and other necessary components.

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Section 26 05 33, Raceways
 - 2. Section 26 05 53, Identification for Electrical Systems

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals not required for this Section.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Outlet Boxes:
 - 1. Bowers
 - 2. Hubbell
 - 3. Raco
 - 4. Steel City
 - 5. Thomas & Betts
 - 6. Or approved equivalent.

- B. Pull and Junction Boxes:
 - 1. B-Line
 - 2. Hoffman
 - 3. Or approved equivalent.

- C. Box Extension Adapter:
 - 1. Bell
 - 2. Carlon
 - 3. Raco
 - 4. Red Dot
 - 5. Steel City
 - 6. Thomas & Betts
 - 7. Or approved equivalent.

- D. Conduit Fittings:
 - 1. Killark
 - 2. O-Z Gedney
 - 3. Raco
 - 4. Steel City
 - 5. Thomas & Betts
 - 6. Or approved equivalent.

- E. Weatherproof Outlet Boxes:
 - 1. Pass and Seymour
 - 2. Bell
 - 3. Red Dot
 - 4. Carlon
 - 5. Or approved equivalent.

2.2 OUTLET BOXES

- A. Luminaire Outlet: 4-inch octagonal box, 1-1/2-inches deep with 3/8-inch luminaire stud if required. Provide raised covers on bracket outlets and on ceiling outlets.

- B. Device Outlet: Installation of one or two devices at common location, minimum 4-inches square, minimum 1-1/2-inches deep. Single- or two-gang flush device raised covers.

- C. Telecom Outlet: Provide 4-inches square, minimum 2-1/8-inch deep box with two-gang plaster ring. Provide under provisions of Division 27, Communications.

- D. Multiple Devices: Three or more devices at common location. Install one-piece gang boxes with one-piece device cover. Install one device per gang.

- E. Masonry Boxes: Outlets in concrete.

- F. Construction: For interior locations, provide galvanized steel outlet wiring boxes, of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

- G. Accessories: Provide outlet box accessories for each installation, including mounting brackets, wallboard hangers, extension rings, luminaire studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.

- H. Noise Control: Provide acoustic putty pad to back side of each outlet box installed in acoustic rated walls.

2.3 PULL AND JUNCTION BOXES

- A. Construction: Provide ANSI 49 gray enamel painted sheet steel junction and pull boxes, with screw-on covers; of type shape and size, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.
- B. Location:
 - 1. Provide junction boxes above accessible ceilings for drops into walls for receptacle outlets from overhead.
 - 2. Provide junction boxes and pull boxes to facilitate installation of conductors and limiting accumulated angular sum of bends between boxes, cabinets and appliances to 270 degrees.
- C. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
 - 1. Construction: Galvanized cast iron.
 - 2. Cover: Smooth cover with neoprene gasket and stainless steel cover screws.
 - 3. Cover Legend: ELECTRIC.
- D. Fiberglass Handholes: Die molded glass fiber hand holes:
 - 1. Cable Entrance: Pre-cut 6- x 6-inch cable entrance at center bottom of each side.
 - 2. Cover: Fiberglass weatherproof cover with nonskid finish.
 - 3. Cover Legend: ELECTRIC.

2.4 BOX EXTENSION ADAPTER

- A. Construction: Diecast aluminum.
- B. Location: Install over flush wall outlet boxes to permit flexible raceway extension from flush outlet to fixed or movable equipment. Basis of Design: Bell 940 Series, Red Dot IHE4 Series.

2.5 CONDUIT FITTINGS

- A. Requirements: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and plastic conduit bushings of the type and size to suit each respective use and installation.

2.6 WEATHERPROOF OUTLET BOXES

- A. Construction: Provide corrosion-resistant cast metal weatherproof outlet wiring boxes, of the type, shape and size, including depth of box, with threaded conduit ends, cast metal faceplate with spring-hinged waterproof cap suitably configured for each application, including faceplate, gasket, blank plugs and corrosion proof fasteners. Weatherproof boxes to be constructed to have smooth sides, gray finish.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate locations of floor boxes and wall mounted wiring device boxes with architectural and structural floor plans prior to rough-in.
- B. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1, Standard Practice of Good Workmanship in Electrical Construction.
- C. Secure boxes rigidly to substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.

- D. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
- E. Set wall mounted boxes at elevations to accommodate mounting heights specified in this Section.
- F. Electrical boxes are shown on drawings in approximate locations unless dimensioned.
 - 1. Adjust box locations up to 10-feet if required to accommodate intended purpose.
- G. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.
- H. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- I. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- J. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12-inches of box.
- K. Box Color Coding and Marking: Reference Section 26 05 53, Identification for Electrical Systems.
- L. Adjust boxes to be parallel with building lines. Boxes not plumb to building lines are not acceptable.
- M. Install knockout closures in unused box openings.
- N. Clean interior of boxes to remove dust, debris, and other material.
- O. Clean exposed surfaces and restore finish.

3.2 OUTLET BOXES INSTALLATION

- A. Mount outlet boxes, unless otherwise required by ADA, or noted on drawings, following distances above finished floor:
 - 1. Control Switches:
 - a. 48-inches to the top of outlet box.
 - b. 4-inches above top of backsplash at countertops/workstations, not-to-exceed 44-inches above finished floor to the top of outlet box per ADA requirements.
 - 2. Receptacles: 15-inches to the bottom of outlet box.
 - 3. Telecom Outlets: 15-inches to the bottom of outlet box. Coordinate with Division 27, Communications.
 - 4. Other Outlets: As indicated in other Sections of specifications or as detailed on drawings.
- B. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6-inches from ceiling access panel or from removable recessed luminaire.
- C. Flush Outlets in Insulated Spaces: Maintain integrity of insulation and vapor barrier.
- D. Coordinate electrical device locations and elevations (switches and receptacles) with architectural drawings to prevent mounting devices in mirrors, back splashes, and behind cabinets.
- E. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- F. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices. Adjacent boxes not aligned vertically to be adjusted at no additional cost to Owner.
- G. Use flush mounting outlet box in finished areas.
- H. Do not install flush mounting box back-to-back in walls; provide minimum 6-inches separation. Provide minimum 24-inches or separated by stud wall partition in acoustic rated walls.
- I. Apply acoustic putty pad on outlet box prior to installation of acoustical blanket.

- J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- K. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- L. Use adjustable steel channel fasteners for hung ceiling outlet box.
- M. Use gang box where more than one device is mounted together. Do not use Sectional box.
- N. Use gang box with plaster ring for single device outlets.
- O. Adjust flush-mounting outlets to make front flush with finished wall material.

3.3 PULL AND JUNCTION BOXES INSTALLATION

- A. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- B. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6-inches from ceiling access panel or from removable recessed luminaire.
- C. Do not fasten boxes to ceiling support wires.
- D. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.4 BOX EXTENSION ADAPTER INSTALLATION

- A. Match material to box.
- B. Install gaskets at exterior and wet locations.

3.5 CONDUIT FITTINGS INSTALLATION

- A. Install set-screw fittings so the screws can be seen from below.
- B. Tighten compression fittings per manufacturer instructions.

3.6 WEATHERPROOF OUTLET BOXES INSTALLATION

- A. Use cast outlet box in exterior locations exposed to weather and wet locations.
- B. Install gaskets.

END OF SECTION

SECTION 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Equipment Nameplates
 - 2. Device Labels
 - 3. Conduit Markers
 - 4. Underground Warning Tape

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals not required for this Section.
- B. In addition, provide:
 - 1. Samples of Nameplates/Labels: One of each type.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
 - 2. Manufacturer's standard products of categories and types required for each application as referenced in other Division 26, Electrical Sections. Where more than a single type is specified for application, provide single selection for each product category.
 - 3. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Equipment Nameplates:
 - 1. B & I Nameplates
 - 2. Intellicum
 - 3. JBR Associates

4. Or approved equivalent.
- B. Device Labels:
1. Kroy
 2. Brady
 3. Or approved equivalent.
- C. Conduit Markers:
1. Allen Systems
 2. Brady
 3. Or approved equivalent.
- D. Underground Warning Tape:
1. Allen Systems
 2. Brady
 3. Or approved equivalent.

2.2 EQUIPMENT NAMEPLATES

- A. Engraved phenolic plastic, laminate, minimum 1/8-inch thick in the size indicated, with beveled edge border matching letter color. Federal specification L-P-387. All upper case letters in engraver standard letter style of the size and wording indicated. Punched for mechanical fastening, except where adhesive mounting is necessary due to substrate. Embossed tape style labels are not acceptable.
- B. Color:
1. Normal (Utility): White letters on black background.
 2. Life Safety/Critical (Emergency Systems): Black letters on orange background per WAC 296-46B-700.9.
 3. Equipment Branch (Legally Required Standby Systems): Black letters on yellow background.
 4. X-Ray Branch (Optional Standby Systems): Black letters on white background.
- C. Letter Size:
1. Use 1/2-inch letters minimum for identifying major equipment and loads, including switchgear, switchboards, etc.
 2. Use 1/4-inch or 1/2-inch letters minimum for identifying panels, breakers, etc.
 3. Use 3/16-inch minimum for identifying source, voltage, current, phase, and wire configurations.
- D. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- E. The Architect, Engineer, Commissioning Agent and Owner reserve the right to make modifications to the nameplates as necessary.
- F. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.
- G. Locations:
1. Switchgear, switchboards, sub-distribution switchboards, distribution panels, and branch panels.
 2. Main breakers and distribution breakers in switchgear, switchboards, and distribution panels.
 3. Equipment including, but not limited to, motor controllers, disconnects, and VFD's.
 4. Low-voltage equipment enclosures including, but not limited to, fire alarm panels, access control panels, and lighting control panels.
 5. Distribution transformers.

2.3 DEVICE LABELS

- A. Label all junction boxes to show system identification, source circuit, or raceway origin. In finished areas, utilize device label. In unfinished areas or above ceilings, use of permanent ink marker is acceptable.
- B. Adhesive tape, with 3/16-inch black letters on clear background. Use only for identification of individual wall switches and receptacles. Indicate device name, source panel, and source circuits. Panel and circuit designation written in permanent marker on the back of the plate and inside the back-box. Do not provide punch tape style labels.
- C. Device plates to have panel and circuit designation engraved in face, and highlighted in a contrasting color, and the circuit written in permanent marker on the back of the plate and inside the back-box.
- D. Where labels are provided, write identical information in permanent ink marker on the backside of the cover.

2.4 CONDUIT MARKERS

- A. Description: Self-sticking vinyl.
- B. Location: Furnish markers for each conduit longer than 6-feet.
- C. Spacing: 20-feet on center.
- D. Color:
 - 1. 240 Volt System: Black letters on Orange background
 - 2. Fire Alarm System: Red

2.5 UNDERGROUND WARNING TAPE

- A. Description: 6-inch wide inert polyethylene plastic tape, 4-mil thick, detectable type, colored per APWA recommendations unless otherwise noted with suitable warning legend describing buried electrical lines.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate designations used on Drawings with equipment nameplates and device labels.
- B. Install nameplates and labels parallel to equipment lines.
- C. Identify empty conduit and boxes with intended use.
- D. Provide typewritten branch panel schedules with protective clear transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designations shown on drawings.
- E. Where changes are made in existing panels, distribution boards, etc., provide new labeling and typewritten schedules to accurately reflect the changes.
- F. Provide color coded boxes as follows:
 - 1. Fire Alarm: Red.

3.2 EQUIPMENT NAMEPLATES

- A. Degrease and clean surfaces to receive nameplates.
- B. Secure equipment nameplates to equipment front using self-tapping stainless steel screws.

- C. Secure equipment nameplates to inside surface of door on panelboard that is recessed in finished locations.
- D. Verify emergency system distribution equipment nameplate colors with Architect/Owner.
- E. Switchboards, and panels to include name source, voltage, current phase, wire configuration and fault current rating.
- F. Provide nameplates for flush mounted branch panelboards identifying name on front door. On inside of door provide nameplate as noted above. Verify with Architect/Owner if nameplate on outside of door is required.
- G. Provide a second label at branch panelboards listing the means of identification of branch circuit conductors. This identification legend to consist of the color code used for each voltage system (120/240V). See specification Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables, for required conductor color code for this project. Include identification of both voltage systems on each label, regardless of the voltage of the panelboard to which the label is affixed. Comply with requirements of NEC 210.5.
- H. Provide engraved nameplate similar to distribution panelboards for transformers, lighting control panels, contactors, relays, time switches, etc. identifying name, service point and circuit number.

3.3 DEVICE LABELS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.
- C. Degrease and clean surfaces to receive labels.
- D. On the front of receptacle and switch finish plates, provide label with the circuit that each device is connected to.

3.4 CONDUIT MARKERS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.5 UNDERGROUND WARNING TAPE

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.
- C. Identify underground raceways using underground warning tape. Install one continuous tape per underground raceway at 6- to 8-inches below finish grade. Where multiple underground raceways are buried in a common trench and exceeds 16-inch width, install multiple warning tapes not over 10-inches apart (edge to edge) over the entire group of underground raceways.

END OF SECTION

SECTION 260573
ELECTRICAL DISTRIBUTION SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. General
 - 2. Arc Flash Labels
 - 3. Selective Coordination Study
 - 4. Arc Flash Hazard Analysis

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - 2. IEEE 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
 - 3. IEEE 1584, Guide for Performing Arc Flash Calculation.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition provide:
 - 1. Power system studies required under this Section with submittals for electrical equipment, including overcurrent protective devices.
 - 2. Electrical equipment ordered prior to submittal of power system studies are not compliant with these specifications, and are subject to removal and replacement at no cost to Owner where not in compliance with Code and Contract Documents for selective coordination.
 - a. Provide written verification with Stamp or Seal and signature of preparing Engineer.
 - 3. Provide samples of NFPA 70E compliant arc flash hazard labeling for electrical equipment.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Study Preparer Qualifications: Qualified engineer of switchgear manufacturer or approved professional engineer.
 - a. Experienced in preparation of studies of similar type and magnitude.
 - b. Familiar with software analysis products specified.
 - 2. Study Preparer Qualifications: Professional electrical engineer licensed in Project location and not employed by manufacturer of equipment to be provided.

3. Study Preparer Qualifications: Electrical testing agency regularly engaged in short circuit and coordination studies, with at least 5 years experience in work of this type, and employing professional electrical engineer licensed in Project location to perform studies.
4. Computer Software for Study Preparation: Use latest edition of commercially available software utilizing specified methodologies.
 - a. Acceptable Software Products:
 - 1) EDSA Micro Corporation.
 - 2) Operation Technology, Inc; ETAP.
 - 3) SKM Systems Analysis, Inc; Power Tools for Windows.
5. Contractor Responsibility: Provide project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, actual circuit lengths and available fault currents from utility. Provide information in a timely matter to allow studies to be completed prior to release of equipment.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Analyze specific electrical and utilization equipment (according to NEC definition), actual protective devices to be used, and actual feeder lengths to be installed.
 1. Scope of Studies: New and existing distribution wiring and equipment, from primary source to buses and branch circuit panelboards.
 2. Primary Source, for Purposes of Studies: Utility company primary protective devices.
 3. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.
 4. Report: State methodology and rationale employed in making each type of calculation; identify computer software package(s) used.
- B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with electrical equipment and wiring to be protected by protective devices; identify nodes on diagrams for reference on report that includes:
 1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at main switchboard bus and downstream devices containing protective devices.
 2. Breaker and fuse ratings.
 3. Generator kW and voltage ratings, percent impedance, X/R ratios, and wiring connections.
 4. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
 5. Identification of each bus, with voltage.
 6. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

2.2 ARC FLASH LABELS

- A. Provide label compliant with NFPA 70E guidelines indicating personal protective equipment (PPE) recommended for servicing of electrical equipment while energized, as well as calculated incident energy levels and arc flash protective boundary distance.

2.3 SELECTIVE COORDINATION STUDY

- A. Perform an organized normal time-current analysis of each protective device in series from individual device back to source, under normal power conditions.

1. Graphically illustrate that adequate time separation exists between series devices, including upstream primary device.
 2. Plot specific time-current characteristics of each protective device on log-log paper.
 3. Organize plots so that upstream devices are clearly depicted on one sheet.
 4. Also show following on curve plot sheets:
 - a. Device identification.
 - b. Voltage and current transformer ratios for curves.
 - c. 3-phase and 1-phase ANSI damage curves for each transformer.
 - d. No-damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum short circuit cutoff point.
 - h. Simple one-line diagram for portion of system that each curve plot illustrates.
 - i. Software report for each curve plot, labeled for identification.
- B. Devices to coordinate down to 0.01 seconds. Coordination required for emergency systems legally required systems and elevators.

2.4 ARC FLASH HAZARD ANALYSIS

- A. Calculate arc flash incident energy (AFIE) levels and flash protection boundary distances to determine required level of personal protective equipment (PPE) at each bus and piece of equipment during normal conditions, emergency power conditions, and other operations that could result in maximum arc flash incident energy levels.
1. Show flash protection boundary distance.
 2. Include incident energy levels.
 3. List required level of protective equipment.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Provide services of qualified field engineer and necessary tools and equipment to test, calibrate, and adjust installed protective devices to conform to requirements determined by coordination analysis.
- B. Adjust installed protective devices having adjustable settings to conform to requirements determined by coordination analysis.
- C. Adjust solid-state protective modules for motors prior to applying load to motor.
- D. Submit report showing final adjusted settings of protective devices.

3.2 ELECTRICAL POWER SYSTEM STUDIES

- A. Selective Coordination Study:
1. Perform time-current coordination analysis with aid of computer software intended for this purpose. Include determination of settings, ratings, or types for overcurrent protective devices supplied.
 2. Where necessary, make an appropriate compromise between system protection and service continuity with service continuity considered more important than system protection.
 3. Provide sufficient number of computer generated log-log plots to indicate degree of system protection and coordination by displaying time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
 4. Computer printouts accompany log-log plots and will contain descriptions for each of devices shown, settings of adjustable devices, short-circuit current availability at device location when

known, and device identification numbers to aid in locating devices on log-log plots and system one-line diagram.

5. Study includes separate, tabular computer printout containing suggested device settings of adjustable overcurrent protective devices, equipment where device is located, and device number corresponding to device on system one-line diagram.
 6. Provide computer generated system one-line diagram which clearly identifies individual equipment buses, bus numbers, device identification numbers and maximum available short-circuit current at each bus when known.
 7. Discussion Section which evaluates degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
 8. Call significant deficiencies in protection and/or coordination to attention of Engineer and recommendations made for improvements as soon as they are identified.
 9. Contractor responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in timely manner to allow time-current analysis to be completed prior to final installation.
- B. Arc Flash Hazard Analysis:
1. Perform arc flash hazard analysis with aid of computer software intended for this purpose.
 2. Perform arc flash hazard analysis in conjunction with short-circuit analysis and time-current coordination analysis.
 3. Submit results of Analysis in tabular form, and include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
 4. Perform analysis under worst-case arc flash conditions, and final report describes, when applicable, how these conditions differ from worst-case bolted fault conditions.
 5. Arc flash hazard analysis includes recommendations for reducing AFIE levels and enhancing worker safety.
 6. Proposed vendor demonstrates experience with arc Flash hazard analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in past year.
 7. Proposed vendor demonstrates capabilities in providing equipment, services, and training to reduce arc flash exposure and train workers in accordance with NFPA 70E and other applicable standards.
 8. Proposed vendor demonstrates experience in providing equipment labels in compliance with CEC and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

END OF SECTION

SECTION 260920 LIGHTING RELAY CONTROL PANEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Materials and Components
 - 2. Hardware Features
- B. Extent of lighting control system work is indicated by drawings, and by the requirements of this Section. It is defined to include lighting relay control panels, switch inputs, energy management system for HVAC and wiring.
- C. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.
- D. Basis-of-Design: Relay panel layout on Drawings are designed based on the Greengate product line. Approved manufacturers listed are allowed on condition of meeting the specified conditions including connectivity with building control systems (fire alarm, security, BAS), fail-safe operation of emergency lighting in compliance with UL 924, and separation of normal and life safety circuits. Provide additional relay enclosures and communications accessories as needed to provide the same level of functionality as shown on Drawings and required in specifications. Remove and replace electrical equipment not meeting these conditions at no cost to Owner.

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Product Data: Submit manufacturer's data on lighting control system and components, including recommended spare parts list.
 - 2. Shop Drawings: Submit drawings of lighting control panel and accessories including, but not necessarily limited to the riser diagram / system diagram, low voltage relay panels, power and communications wiring and termination, input/output schedules and sequence of operation for each control zone.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Test the control panels and list under the UL 916 Energy Management Equipment standards.
 - 2. California Energy Code (CEC) Compliance.
 - 3. Comply with applicable CEC requirements regarding electrical wiring standards.

4. NEMA Compliance: Comply with applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.
5. Component Pretesting: Control equipment to undergo strict inspection standards. Previously test the equipment and burn-in at the factory prior to installation.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 1. Provide a 3-year warranty on hardware and software. Systems that provide special warranties based on installation are not acceptable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Greengate Lighting Control Panels Litekeeper 8
- B. Leviton Lighting Controls
- C. WattStopper
- D. Intelligent Lighting Controls
- E. Lighting Control and Design
- F. Or approved equivalent.

2.2 MATERIALS AND COMPONENTS

- A. System Description:
 1. The lighting control system consists of low voltage relay control panels with 64 programmable switch inputs and up to 8 relays.
 2. Each low voltage lighting control panel is microprocessor controlled. Accomplish programming through either the RS-232 port or through the network connection or with an integral 2 x 16 - 32 character self-prompting LCD display and programming keypad.
 3. Programmable intelligence includes time-of-day control, 32 holiday dates, a Warn Off to warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control, digital switches and network overrides.
 4. When control panel provides a Warn Off (flash the lights) to inform the occupants of an impending off command, the Warn Off command will allow 10 extra minutes for the occupants to override their lights or exit the premises.
 5. Control panels permits lighting to be overridden ON for after-hours use or cleaning. Provide these overrides with hard-wired inputs or voice-guided touch-tone telephone control.
 6. Control panel enclosures offer a maximum space of 8 relays.
- B. Basis of Design: Lighting relay panels on Drawings are designed based on Greengate Lighting Control Panels Litekeeper product line. Approved manufacturers listed below are allowed on condition of meeting the specified conditions including the available space for the equipment (including Code required working clearances). Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.3 HARDWARE FEATURES

- A. Diagnostic Aids:

1. Each control panel to incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids to guide the individual in rapid troubleshooting of the system.
 2. The control panels to employ both a backlit LCD and LED's to indicate:
 - a. POWER (LED)
 - b. SYSTEM OK (LED)
 - c. ON/OFF STATUS of EACH RELAY (LED & LCD)
 - d. SYSTEM CLOCK AND DATE (LCD)
 - e. PROGRAMMING CONFIRMATION (LCD)
 3. Control systems that do not provide visual self-help diagnostics are not acceptable.
- B. Status Indication of Relays: System will provide visible status indication of relays through the window of each control panel. Visual indication to disclose ON/OFF status and relay number. Systems that do not provide relay status while the enclosure door is closed are not acceptable.
- C. Operator Interface: The control panel programming interface resides in firmware in the control panel. The programming interface to consist of a circuit board mounted keypad and 2 line x 16 character LCD display. The integral keypad to provide access to the main programming features. Keypad to permit user to manually command any or all relays individually. Keypad to also allow user to link switch inputs and time schedules to relay outputs. Each panel to control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks is not permitted. Systems that utilize blocking diode technology for relay assignments are not acceptable.
- D. Overrides: Controller to provide timers for each override. Provide each override timer capable of 0-999 minutes. Software to enable or disable overrides based on Priorities, Masks or Time of Day scheduling.
- E. Digital Switch: Lighting controller to support digitally addressable LED annunciated switches. Maximum total number of digital switches that may exist on the lighting control network is 16,320. Each Subnet to support 64 buttons. The digital switch network requires CAT 5 cable between switches. Digital switches to control any relay group combination on the Greengate Lighting Control Panels network. Provide data communications status feedback for system checkout and troubleshooting (transmit and receive LED'S) visible on the interface.
1. Digital switch configuration system to permit custom labeling for multiple button switch locations. Provide Decora® form and function Digital switch configuration.
- F. Dry Contact Inputs: Control system to permit 8 dry contact inputs for override purposes. Support momentary 3 wire or 2 wire (toggle) inputs. Support maintained contacts as 2 wire (SPST) inputs. Provide dry contact inputs (24VDC at 12 ma. internally supplied to the inputs). 24VDC power supply is provided with an auto-resettable fuse. Should an inappropriate electrical connection be made, design to protect the board and switches until the fault is removed. Software link switch input to any number of relays for override control. Control panel to have dry contact inputs on the logic board. Control systems that utilize separate accessories to allow for dry contact switches are not acceptable. Control systems that do not supply both digital switches and analog switches from the same controller are not permitted.
- G. Photocell Control: Controller to accept dry contact ambient light sensors. Controller to provide power for the sensor thereby eliminating any external power supply. Sensors to provide for outdoor and indoor applications and issue a command to the controller once the threshold is reached. Sensor to provide user adjustable dead band control.
- H. Remote Overrides: Controller to accept remote commands issued from other inputs. Controller to provide this feature without the need to add extra equipment to the controller. Remote overrides can be issued from the Telephone Interface Module (TIM), Photocells, Motion Sensors, Digital or Dry Contact Switches. Lighting systems that need to add extra equipment to receive remote overrides are not acceptable.
- I. Service Override and Priority Override: Control panel to provide a three position master-service override for the control unit. Provide service override that is not accessible from the exterior. Systems that provide a service override on the exterior of the controller are not acceptable.

- J. Modular Design:
1. Control system to employ modular connectors to avoid repeat wiring in case of component failure. Mount the system CPU board on quick-release spring pins that permit an entire change out of the processor and input board.
 2. Connections for the switch inputs to incorporate modular connectors. Provide modular relay board designed for rapid field replacement or upgrading. Systems that do not employ modular connectors are not acceptable.
- K. Battery Back-up: The system to utilize a memory back-up device that is system integrated and non-serviceable. Protect the data in RAM against power interruptions lasting as long as 10 years. Provide maintenance free power interrupt protection circuit.
- L. Multi-tapped Transformer: The control panel incorporates the use of a multi-tapped transformer. No specification of voltage for each control location is required by panel. The voltages of 120 and 277VAC available with each standard control panel.
- M. Status Indication of Relays: System to provide visible status indication of relays through the window of each control panel. Visual indication to disclose ON/OFF status and relay number.
- N. Service Override: Control panel to provide a 3 position service override for the entire panel. Provide service override that is not accessible from the exterior.
- O. Lockable Enclosure: Enclose each control panel in a lockable NEMA Class 1 enclosure and provide pre-punched knockouts.
- P. Relays: Electrically held 20amp 120/277VAC relays. Relays must be specified Normally Open or Normally Closed. Rate the relays for 10 million mechanical operations.
1. RS-232 port: Controller to provide an RJ-12 connection for RS-232 communications. Permit programming through either a local connection or remotely through a modem. The Keeper Enterprise software accessory includes a six wire communication cable to connect to the controller. Systems that do not include an on-board RS-232 port for communications are not acceptable.
 2. Monitoring / Control Software: The PC based interface software accessory provides access to lighting control system files within a Microsoft® Windows® environment. Provide software to support Windows® 2000, Windows® XP and above. The software package allows individual panel programming to be executed locally, via direct connection or remotely through a TCP/IP connection or modem. The central programming software permits the user to modify the control panel programming or configuration in an "OFF-LINE" mode. This software package stores programmed data and archives for future use. Systems using third party software are not acceptable. Systems that are not capable of creating program backups are not acceptable.
 - a. Provide the following features standard in the PC based software:
 - 1) Standard Software Features:
 - 2) Real Time Relay Status Monitoring
 - 3) Alpha-Numeric Descriptors
 - 4) Communications: Direct, TCP/IP and Modem
 - 5) Status Indication
 - 6) Global Software Modifications
 - 7) Manual Relay Commands
 - 8) Relay Pattern Commands
 - 9) Preset Options
 - 10) User Management - Password protection and privilege modification for multi-user security.
 - 11) Logging of Controller Actions (switch inputs, TIM commands and relay actuations)
 - b. File Maintenance
 - 1) Archive Programs
 - 2) Data Base Restoration
 - 3) Uploading and Downloading of Programs
 - 4) Snap Shots - indication of changes and flawless panel restoration.

- c. Software package to permit the PC to be utilized for other functions (i.e. word processing, database, etc.) besides lighting control. Systems that require an "on-line" dedicated computer for control system operation are not acceptable.
3. Stand Alone Hardware Accessories:
 - a. Ethernet Interface Module (EIM): Internet Connection Specifications: The control system accessory provides access to control panels over a TCP/IP connection by converting sent information into RS-232 communication capable information. This unit operates on standard 110VAC. Manufacturer to provide proper cabling from controller to Ethernet Interface Modules. RJ-45 connections are the responsibilities of others.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Installation: Install the control system and fully wire as shown on the drawings by the installing contractor. Complete electrical connections to control circuits, and override wiring.
- B. Documentation: Provide accurate record drawings to the Owner for correct programming and proper maintenance of the control system. Record Drawings to indicate the load controlled by each relay and the relay panel number.
- C. Operation and Maintenance Manuals: Provide factory operation and maintenance manuals.

3.2 PRODUCT SUPPORT AND SERVICE

- A. Factory Support: Provide factory telephone support available at no cost to the Owner. Factory assistance to consist of solving programming or application questions concerning the control equipment.

3.3 SYSTEM ACCEPTANCE

- A. Test to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings and specifications.
- B. Functionally test sequences of operation to ensure operation in accordance with approved drawings and specifications.
- C. Prepare and complete report of test procedures and results and file with the Owner.
- D. An operational user program to exist in the control system. Program to execute and perform functions required to effectively operate the site according to the requirements.
- E. Demonstration of program integrity during normal operation and pursuant to a power outage.
- F. Provide a minimum of 2 hours training on the operation and use of the control system.
- G. Lighting System Control Testing and Commissioning:
 1. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.
 2. Testing to Include:
 - a. Daylight Automatic Controls
 - b. Occupant Sensing Automatic Controls
 - c. Automatic Time and Override Controls for Interior Lighting
 - d. Automatic Time and Photo Controls for Exterior Lighting

END OF SECTION

**SECTION 260923
OCCUPANCY_VACANCY SENSORS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Occupancy/Vacancy Sensors (Ceiling and Wall mounted)
 - 2. Combined Occupancy Sensor/Wall Switches ("Sensor/Switches")
 - 3. Automatic Switches

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Provide wiring diagrams indicating low voltage and line voltage wiring requirements.
 - 2. Provide, on reproducible architectural floor plan, a layout of sensors indicating their sensing distribution.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Use manufacturer's published testing and adjusting procedures to adjust sensors time delay, daylight sensitivity, and passive infrared sensitivity to satisfaction of the Owner, in accordance with California Title 24 requirements.
 - 2. Prepare and complete report of test procedures and results. Submit these test procedures and results to Owner and Engineer and Architect.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Occupancy/Vacancy Sensors (Ceiling and Wall mounted):
 - 1. Passive Infrared Occupancy/Vacancy Sensors:
 - a. Sensor Switch
 - b. WattStopper
 - c. Leviton

- d. Hubbell
 - e. Greengate
 - f. Or approved equivalent.
2. Ultrasonic Occupancy/Vacancy Sensors:
- a. WattStopper
 - b. Leviton
 - c. Hubbell
 - d. Greengate
 - e. Sensor Switch
 - f. Or approved equivalent.
3. Dual Technology Occupancy/Vacancy Sensors:
- a. WattStopper
 - b. Leviton
 - c. Hubbell
 - d. Greengate
 - e. Sensor Switch
 - f. Or approved equivalent.
- B. Combined Occupancy/Vacancy Sensor:
- 1. Sensor Switch
 - 2. WattStopper
 - 3. Leviton
 - 4. Hubbell
 - 5. Greengate
 - 6. Or approved equivalent.
- C. Automatic Switches:
- 1. Sensor Switch
 - 2. WattStopper
 - 3. Leviton
 - 4. Hubbell
 - 5. Greengate
 - 6. Or approved equivalent.
- D. Basis of Design: Occupancy/Vacancy sensor layout on Drawings are designed based on WattStopper product line. Approved manufacturers listed are allowed on condition of meeting the specified conditions including complete sensor coverage of the area controlled and switching of luminaires in the area controlled. Provide additional sensors and power switch packs as needed to provide the same level of functionality as shown on Drawings or required in Specifications. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.2 GENERAL

- A. Occupancy sensor designation indicates sensors automatically turn lights ON when the sensor detects the presence of a person and will automatically turn lights OFF when no presence is detected for a specified amount of time (automatic-on and automatic-off).
- B. Vacancy sensor designation requires someone to manually turn the lights ON. The sensor will then automatically turn the lights OFF when no presence is detected for a specified amount of time (manual-on and automatic-off). These sensors must meet California Title 24 requirements.
- C. Provide occupancy sensors to sense presence of human activity within desired space and enable or disable on/off manual lighting control function provided by local switches.
- D. Upon detection of human activity by detector, sensor initiates time delay to maintain lights on for present period of time. Field adjustable time delay setting from 30 seconds to 15 minutes.

- E. Factory set sensors for maximum sensitivity.
- F. LED lamp built into sensor indicates when occupant is detected.
- G. Provide zero cross relay control with sensors and sensor/switched; relay contacts close and open with AC voltage signal is at zero.
- H. Where line voltage sensors and sensor/switches are used, provide to match voltage of controlled circuit.
- I. Line Voltage Sensors, Control Units, and Relays: UL listed.

2.3 OCCUPANCY/VACANCY SENSORS (CEILING AND WALL MOUNTED)

A. Passive Infrared Sensors:

1. Sensor Function: Detects human presence in floor area being controlled by detecting changes in Infrared energy. Sensor detects small movements, i.e., when people are writing while seated at a desk.
2. Provide temperature compensated dual element pyro-electric sensor and with multi element Fresnel lens.
3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
4. Provide daylight filter to ensure that sensor is insensitive to short-wavelength infrared waves, i.e., those emitted by sun.
5. Adjustments and mounting hardware under removable cover to prevent tampering with adjustments and hardware.
6. Sensor utilizes advanced digital signal processing technology to reduce false offs without reducing sensitivity.
7. Ceiling-Mounted Sensor:
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. 360 degree sensor range; coverage: 1200 SF, unless otherwise noted on drawings.
 - c. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
 - d. Provide internal form C dry contacts for HVAC control.
 - e. Basis of Design: Wattstopper CI-300 Series
8. Wall-Mounted Sensor:
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. 90 degree sensor range with dense wide angle lens; coverage: 1000 SF for desktop motion, unless otherwise noted on Drawings.
 - c. Swivel mounting bracket for corner mounting to wall or ceiling.
 - d. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
 - e. Provide internal form C dry contacts for HVAC control.
 - f. Basis of Design: Wattstopper CX Series
9. Building Exterior Sensor:
 - a. Capable of mounting on walls, eaves or ceilings.
 - b. On/off control based on daylight levels via adjustable light level setting.
 - c. Line Voltage: provide sensor to match voltage of lighting controlled; capable of switching up to 1000 watts ballast and incandescent load.
 - d. Adjustable time delay from 15 seconds to 15 minutes.
 - e. Silicon gasketed to prevent water and dust intrusion. UL listed raintight.
 - f. Rated to operate in temperatures from -40 degrees F to 130 degrees F.
 - g. Provide each sensor with manufacturer supplied wire-guard.
 - h. Provide isolated relay for monitoring by security system
 - i. Coverage:
 - 1) Narrow beam up to 100 foot distance.

- 2) 90 degree beam up to 50 foot distance.
- j. Finish: White or as selected by Architect.
- k. Basis of Design: Wattstopper EN Series
- l. Parking Lot Lighting Control:
 - 1) On/off control based on daylight levels via adjustable light level setting.
 - 2) Low Voltage Sensor: 24VDC power. Sensor operates luminaire high/low control.
 - 3) Adjustable time delay from 15 seconds to 15 minutes.
 - 4) Silicon gasketed to prevent water and dust intrusion. UL listed raintight.
 - 5) Rated to operate in temperatures from -40 degrees F to 130 degrees F.
 - 6) Sensor front rotates and pivots for coverage adjustment after installation.
 - 7) Basis of Design: Wattstopper EW Series

B. Ultrasonic Occupancy/Vacancy Sensors:

- 1. Sensor Function: Detects human presence in controlled floor area by detecting Doppler shifts in 40kHz ultrasound created by sensor.
- 2. Sensors are precision crystal controlled and do not interfere with each other when two or more are placed in same area. Sensor includes advanced digital signal processing to reduce false on signals without decreasing sensitivity, as well as immunity to RFI/EMI sources.
- 3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
- 4. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
- 5. Provide adjustments and mounting hardware under removable cover to prevent tampering.
- 6. Ceiling-Mounted Sensor:
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. Maximum protrusion of 1.1-inches and blend in aesthetically with ceiling.
 - c. Coverage: 360 degree sensor range; coverage: 2,000 SF, unless otherwise noted on Drawings.
 - d. Provide internal form C dry contacts for HVAC control.
 - e. Basis of Design: Wattstopper WT Series
- 7. Ceiling Mounted Sensor - Hallway Sensor Coverage:
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. Maximum protrusion of 1.5-inches and blend in aesthetically with ceiling.
 - c. Coverage: 90 lineal feet.
 - d. Provide internal form C dry contacts for HVAC control.
 - e. Basis of Design: Wattstopper UT-300-3 Series

C. Dual Technology Sensors:

- 1. Sensor Function: Combined capability of passive infrared with ultrasonic or microphonic technology as described above.
- 2. Function: Upon a person entering a space, motion must be sensed by both technologies before lighting will be turned on. After this has occurred, detection by either technology will hold lighting on. Sensors retrigger time delay where only one motion is necessary to turn on lights within 5 seconds after turning off.
- 3. Wall-Mounted Sensor:
 - a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - b. 90 degree sensor range with dense wide angle lens, coverage; 1000 SF for desktop motion, unless noted on drawings.
 - c. Swivel mounting bracket for corner mounting to wall or ceiling.
 - d. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
 - e. Provide internal form C dry contacts for HVAC control.
 - f. Basis of Design: Wattstopper DT Series
- 4. Ceiling-Mounted Sensor:

- a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
- b. 360 degree sensor range; coverage: 1000 SF for half-step motion, unless otherwise noted on Drawings.
- c. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
- d. Provide internal form C dry contacts for HVAC control.
- e. Basis of Design: Wattstopper DT-300 Series

2.4 COMBINED OCCUPANCY/VACANCY SENSOR/WALL SWITCHES ("SENSOR/SWITCHES")

- A. Completely self-contained sensor system that fits into standard single gang box. Internal transformer power supply, latching dry contact relay switching mechanism compatible with electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices are not allowed.
- B. Passive infrared sensor technology includes advanced signal processing to reduce false triggers without increasing sensitivity. LED indicator blinks when occupant sensed.
- C. Rated to switch loads: 800 watts incandescent or 120-volt ballast; 1000 watts 277 volt ballast. Zero-crossing technology switches lighting off when AC voltage is at zero, minimizes contact wear.
- D. Provide adjustable daylight feature that holds lighting "off" when desired footcandle level is present.
- E. Provide integral off override switch with no leakage current to load or ground.
- F. Vandal-resistant lens.
- G. Includes neutral wire to meet NEC 2014 Code.
- H. Finish: White.
- I. Alerts for impending shut-off: light flash, audible, both or none.
- J. Standard Sensor/Switch:
 - 1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off). Factory set to manual on/auto off.
 - 2. 180 degree sensor range; coverage: 150 SF for desktop activity.
 - 3. Basis of Design: Wattstopper PW-101 Series
- K. Dual Relay Sensor/Switch:
 - 1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - 2. Dual auto-off buttons on face of switch allow end-user to turn off two switch legs in room space. Built-in light adjustable level sensor only turns off second of two relays when desired footcandle level is present. Otherwise similar to specifications above for single-zone sensor/switch.
 - 3. Defaults to Manual-ON to 50% operation for maximum energy savings.
 - 4. 180 degree sensor range; coverage: 150 SF for desktop activity.
 - 5. Finish: White.
 - 6. Basis of Design: Wattstopper PW-302
- L. Sensor/Slide Dimmer:
 - 1. Line voltage slider dimmer allows for manual adjustment of lighting levels from 100 percent to 10 percent; compatible with two-wire line voltage 100 percent to 10 percent electronic dimming ballasts. Separate manual button for override 'off' control.
 - 2. 180 degree sensor range; coverage: 300 SF for desktop activity.
 - 3. Basis of Design: Wattstopper PW-100D/101D Series
- M. Passive Infrared Wall Switch Vacancy-Only Sensors:

1. Operates only as a vacancy sensor (manual-on and automatic-off) in accordance with California Title 24 requirements.
 2. Adjustable sensitivity (high, low presets).
 3. Basis of Design: Lutron Maestro MS Series.
- N. Dual Technology Wall Switch Vacancy-Only Sensors:
1. Operates only as a vacancy sensor (manual-on and automatic-off) in accordance with California Title 24 requirements.
 2. Adjustable sensitivity (high, medium, low, and off presets) individually for passive infrared and ultrasonic sensing.
 3. Basis of Design: Lutron Maestro MS Series.
- O. Passive Infrared Wall Dimmer Vacancy-Only Sensors:
1. Operates only as a vacancy sensor (manual-on and automatic-off) in accordance with California Title 24 requirements.
 2. If more than one model is required, the optional choice can be used to assign type designations. Make sure that designations indicated on the drawings are consistent with those specified here.
 3. Basis of Design: Lutron Maestro MSCL Series.
- P. Passive Infrared 0-10 V Wall Dimmer Vacancy-Only Sensors:
1. Operates only as a vacancy sensor (manual-on and automatic-off) in accordance with California Title 24 requirements.
 2. If more than one model is required, the optional choice can be used to assign type designations. Make sure that designations indicated on the drawings are consistent with those specified here.
 3. Basis of Design: Lutron Maestro 0-10V Dimmer Sensor MS Series.

2.5 AUTOMATIC SWITCHES

- A. Automatic ("Sentry") Switch:
1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 2. Controls up to 1800 watts at 120-volt, 4100-watts at 277-volt, suitable for ballast and motor loads.
 3. Compatible with Decora style faceplate.
 4. Zero crossing circuitry.
 5. Finish: Match wiring devices unless selected otherwise by Architect.
 6. Capable of being connected with other sentry switches to produce 3 and 4 way switching.
 7. Based on power interruptions of following durations from an upstream control panel, produces following effects:
 - a. 5 Seconds: Turns lighting off with no delay.
 - b. 3 Seconds: Turns lighting on with no delay.
 - c. 1 to 2 Seconds: Delayed off. Blinks lights and provides audible signal to room occupant. If switch push button is not pressed within 5 minutes, lights are turned off.
 8. Basis of Design: Wattstopper AS-100 Series
- B. Digital Timer Switch:
1. Controls up to 1800 watts at 120 volt, 4100 watts at 277 volt, suitable for ballast and motor loads.
 2. Compatible with Decora style faceplate.
 3. Provide low voltage (24VAC/VDC) version where used as input to lighting relay panel; includes single-pole, double-throw isolated relay rated for 1A at 30VDC.
 4. Electroluminescent LCD display shows timer countdown.

5. Time out setting range from 5 minutes to 12 hours. Lights can be turned off before time-out setting by holding down on/off button.
6. Timer countdown can be reset to beginning by holding down push button for 2 seconds.
7. Zero crossing circuitry.
8. Finish: White.
9. Room lighting flashed and switch beeps 5 minutes and 1 minute prior to switching room lighting off. Either visible or audible features can be disabled.
10. Basis of Design: Wattstopper TS-400 Series

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install occupancy/vacancy sensors as directed by manufacturer's instructions. Complete connections to control circuits, occupancy sensors, power supply pack and low voltage wiring.
- B. Provide power packs for sensor to control number of circuits and/or switch legs within its area of coverage.
- C. Field adjust each sensor to maximize its coverage of room space.
- D. Relocate sensors with ultrasonic technology to avoid being closer to HVAC diffusers and power packs than recommended by manufacturer.
- E. Field set time delay for each device as noted below:
 1. Conference Rooms: 30 minutes.
 2. Restrooms: 15 minutes.
 3. Storage Rooms, Janitor's Closets, Unisex Restrooms: 5 minutes.
 4. All Other Spaces: 15 minutes.
 5. Time Switches: 2-hours.
- F. Prior to applying dimming controls, maintain fluorescent lighting at full output for minimum of 100 hours. If this is not done, replace lamps and ballasts of affected luminaires at no cost to Owner.
- G. Coordinate HVAC control requirements with controls contractor prior to installation.
- H. Lighting System Testing and Commissioning:
 1. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.
 2. Testing includes:
 - a. Daylight Automatic Controls
 - b. Occupant Sensing Automatic Controls
 - c. Automatic Time and Override Controls for Interior Lighting
 - d. Automatic Time and Photo Controls for Exterior Lighting

3.2 OCCUPANCY/VACANCY SENSORS (CEILING AND WALL MOUNTED)

- A. See General Installation Requirements above.
- B. Install per manufacturers written instructions and requirements.

3.3 COMBINED OCCUPANCY SENSOR/WALL SWITCHES ("SENSOR/SWITCHES")

- A. See General Installation Requirements above.

B. Install per manufacturers written instructions and requirements.

3.4 AUTOMATIC SWITCHES

A. See General Installation Requirements above.

B. Install per manufacturers written instructions and requirements.

END OF SECTION

SECTION 260924 DAYLIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Continuous Dimming Daylighting Controller
 - 2. Switched Daylighting Controller
 - 3. Local Continuous Dimming Photosensor
 - 4. Local Switched Photosensor

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards per Division 01, General Requirements and Section 26 00 00, Electrical Basic Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Wiring diagrams indicating low voltage and line voltage wiring requirements.
 - 2. A layout of sensors indicating their sensing distribution on reproducible architectural floor plan.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Daylighting controls that carry a factory warranty for a minimum 5-year duration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Continuous Dimming Daylighting Controller:
 - 1. WattStopper
 - 2. Greengate
 - 3. Sensor Switch
 - 4. Or approved equivalent.
 - 5. Basis of Design: Daylighting sensor layout on Drawings are designed based on WattStopper or nLight product line. Approved manufacturers listed below are allowed on condition of meeting specified conditions including complete sensor coverage of area controlled and switching of

luminaires in area controlled. Provide additional sensors and power switch packs as needed to provide same level of functionality as shown on Drawings. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

B. Switched Daylighting Controller:

1. WattStopper
2. Greengate
3. Sensor Switch
4. Or approved equivalent.
5. Basis of Design: Daylighting sensor layout on Drawings are designed based on WattStopper or nLight product line. Approved manufacturers listed below are allowed on condition of meeting specified conditions including complete sensor coverage of area controlled and switching of luminaires in area controlled. Provide additional sensors and power switch packs as needed to provide same level of functionality as shown on Drawings. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

C. Local Continuous Dimming Photosensor:

1. WattStopper
2. Greengate
3. Sensor Switch
4. Or approved equivalent.
5. Basis of Design: Daylighting sensor layout on Drawings are designed based on WattStopper product line. Approved manufacturers listed below are allowed on condition of meeting specified conditions including complete sensor coverage of area controlled and switching of luminaires in area controlled. Provide additional sensors and power switch packs as needed to provide same level of functionality as shown on Drawings. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

D. Local Switched Photosensor:

1. WattStopper
2. Greengate
3. Sensor Switch
4. Or approved equivalent.
5. Basis of Design: Daylighting sensor layout on Drawings are designed based on WattStopper product line. Approved manufacturers listed below are allowed on condition of meeting specified conditions including complete sensor coverage of area controlled and switching of luminaires in area controlled. Provide additional sensors and power switch packs as needed to provide same level of functionality as shown on Drawings. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.2 CONTINUOUS DIMMING DAYLIGHT CONTROLLER

- A. Control dimming of interior lights in response to light level data, compatible with 0 to 10VDC dimming ballasts. Control system to be open loop, to provide three output control zones consisting of a 0 to 10VDC signals compatible with fluorescent dimmable ballasts. Control system to include three relay outputs capable of switching each of three output zones off after an adjustable time delay when a given channel is fully dimmed.
- B. Control module to include following characteristics:
1. Seven individually adjustable parameters for each channel:
 - a. Setpoint: 5 to 60 footcandles;
 - b. Minimum Output: 0 to 4 volts DC;
 - c. Maximum Output: 6 to 10 volts DC;
 - d. Ramp Rate: 5 to 60 seconds;
 - e. Fade Rate: 5 to 60 seconds;
 - f. Cutoff Time Delay: 0 to 20 minutes or disabled;

- g. Load Shed Limit: 0 to 10 volts DC.
 - 2. Compatible with 0 to 10VDC dimming ballasts.
 - 3. Suitable for panel mounting on DIN rail.
 - 4. When daylighting is adequate for a channel to fully dim; lights switch off after an adjustable time delay via relay pack connected to controller. This feature can also be disabled if lights must remain when fully dimmed.
 - 5. LCD display with menu-driven, pushbutton programming without special tools or accessories; automatic internal calculation for dimming requirements of individual channels for simplified setup.
 - 6. Operates from either 120VAC or 277VAC power source.
- C. Utilize low voltage photosensor to continuously measure light levels. Photosensor range is 30 to 6000 footcandles. Adjustments and calibrations capable of being made at control module, not at remote photosensor.
 - D. Basis of Design: WattStopper LCD-203 series control module with LS-290C photosensor and WattStopper BT-203 power pack. Control module mounted in factory-approved enclosure with factory-installed DIN rails (WattStopper LS-E8, LS-E12, or approved equivalent) and DC power supplies as needed.

2.3 SWITCHED DAYLIGHTING CONTROLLER

- A. Switched control of interior lights in response to photocell input. Control system to be open loop, and will provide three output control zones as shown on Drawings.
- B. Control module will include following characteristics:
 - 1. Five individually adjustable parameters for each channel:
 - a. Setpoint: 5 to 60 footcandles;
 - b. Programmable Deadband: 10 to 80 percent;
 - c. On Delay: 5 to 60 seconds;
 - d. Off Delay: 3 to 60 minutes;
 - e. Load Shed Limit: 5 to 60 footcandles.
 - 2. Compatible with 0 to 10VDC dimming ballasts.
 - 3. Suitable for panel mounting on DIN rail.
 - 4. Lights switched via relay pack connected to controller.
 - 5. LCD display with menu-driven, pushbutton programming without special tools or accessories; automatic internal calculation for dimming requirements of individual channels for simplified setup.
 - 6. Operates from either 120VAC or 277VAC power source.
- C. Utilize low voltage photosensor to continuously measure light levels. Photosensor range is 30 to 6000 footcandles. Adjustments and calibrations will be capable of being made at control module, not at remote photosensor.
- D. Basis of Design: WattStopper LCO-203 series control module with LS-290C photosensor and WattStopper BT-203 power pack. Mount control module in factory-approved enclosure with factory-installed DIN rails (WattStopper LS-E8, LS-E12, or approved equivalent) and DC power supplies as needed.

2.4 LOCAL CONTINUOUS DIMMING PHOTONSENSOR

- A. Provide low voltage, indoor photocell to interface with electronic dimming ballasts using low voltage (0 to 10VDC) control signal.
- B. Spectral filtering system to measure relative levels of daylighting and indoor lighting within control space. Measures light as human eye perceives; linear photocell response with greater than 1 percent accuracy.

- C. Ceiling-mounted 2.4-inch diameter, 0.875-inch depth white housing.
- D. 10VDC input voltage, 0.2 to 10VDC output voltage. 20 to 60 footcandle adjustable range with plus or minus 3 percent accuracy. One photocell controls up to 50 ballasts. 5 year warranty. White finish.
- E. Provide with separate handheld remote controller to field program target lighting levels for daytime and nighttime (i.e. when plenty of daylighting is available and when no daylighting is available).
- F. Basis of Design: WattStopper LS-301 Series.

2.5 LOCAL SWITCHED PHOTOSENSOR

- A. Low voltage, indoor photosensor to switch lighting using power pack; integrate with room occupancy sensors.
 - 1. LCD display under removable cover to display four user-adjustable parameters:
 - a. ON Setpoint.
 - b. 1-850 footcandles.
 - c. OFF Setpoint (25 percent to 100 percent above ON Setpoint).
 - d. OFF Setpoint time delay (3 to 30 minutes).
 - 2. Dimensions: 2.4-inches diameter by 0.7-inches deep.
 - 3. White finish; surface mounted. Mountable in top-lit or side-lit position.
 - 4. Voltage: 12/24VDC. LED status indicator.
- B. Basis of Design: WattStopper LS-101 Series.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install photocells as directed by manufacturer's instructions. Complete connections to control circuits, photocells, control modules, power supply pack and low voltage wiring.
- B. Photocell placement and wiring:
 - 1. Drawings are schematic, and show photocell quantities together with the daylighting zones that they control.
 - 2. Reference manufacturer installation instructions for the recommended location and orientation of photocell with respect to exterior glazing and both interior and exterior lighting.
 - 3. Reposition sensor at no additional cost to Owner to avoid conflict between sensor and object obscuring its view, and between sensor and both interior and exterior lighting that causes daylighting controls to repeatedly increase and decrease in brightness (i.e. "cycling").
 - 4. Field wire photocell for correct footcandle range (i.e. WattStopper LS-290C photocell has three jumper selectable footcandle ranges: 3 to 300 fc, 30 to 3000 fc, 60 to 6000 fc).
- C. Prior to applying continuous dimming daylighting controls, maintain fluorescent lighting at full output for minimum of 100 hours. If this is not done, replace lamps of affected luminaires at no cost to Owner.

3.2 LIGHTING SYSTEM DEMONSTRATION, TRAINING, TESTING AND COMMISSIONING

- A. Prior to adjusting and calibrating daylighting control system and local photocell field adjustable settings, contact local manufacturer representative and arrange for representative to visit site to educate both field installer and Owner representative on the operation of the controls.
- B. Use manufacturer's published testing and adjusting procedures to adjust sensors and daylight sensitivity to the satisfaction of Owner.

- C. Prepare and complete report of test procedures and results. Submit these test procedures and results to Engineer.
- D. Training: Provide minimum 2-hour training session to Owner representatives at a time approved by Owner after Owner has received approved operation and maintenance manuals. Training to include discussion of operation, adjustment, and replacement of sensors, photocells and control.
- E. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.
- F. Testing Includes:
 - 1. Daylight Automatic Controls
 - 2. Occupant Sensing Automatic Controls
 - 3. Automatic Time and Override Controls for Interior Lighting
 - 4. Automatic Time and Photo Controls for Exterior Lighting

END OF SECTION

SECTION 262416 PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Panelboards

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. UL 67, Standards for Panelboards.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Panelboards:
 - 1. Eaton
 - 2. General Electric
 - 3. Siemens
 - 4. Schneider Electric/Square D
 - 5. Or approved equivalent.
- B. Manufacturers listed above are allowed on condition of meeting specified conditions including available space for equipment, Code required working clearances, and selective coordination per Section 260573, Electrical Distribution System Studies can be met. Prior to submitting bid, manufacturer to provide documentation to Engineer verifying specific conditions, including those mentioned above, can be met. Remove and replace electrical equipment installed, at no cost to the Owner, that does not meet these conditions.
- C. Basis of Design: Eaton, GE, Siemens, or Schneider Electric/Square D. Manufacturers listed are allowed on condition of meeting specified conditions including available space for the equipment

and Code required working clearances and selective coordination per Section 260573, Electrical Distribution System Studies. Remove and replace electrical equipment installed that does not meet these conditions at no cost to Owner.

2.2 PANELBOARDS

- A. Description: Panelboards 400 amps or less. NEMA PB1, Type 1 as indicated on drawings, circuit breaker type. Maximum enclosure depth: 6-inches for surface mounted, 5 3/4-inches for flush mounted.
- B. Maximum Width: 20-inches.
- C. Integrated Equipment Rating: Provide fully rated integrated equipment rating greater than the available fault current. Series rated panelboards are not acceptable. Reference drawings for available fault current. If drawings do not have available fault current shown, then coordinate with serving electrical utility. Final rating based on the protective device study completed under the provisions of Division 26, Electrical Distribution System Studies.
- D. Panelboard Bus Non-Reduced: Copper, ratings as indicated on drawings. Bus bar with suitable electroplating (tin) for corrosion control at connection. Provide copper ground bus in each panelboard.
- E. Lugs: Mechanical type for conductors.
- F. Provide double lugs and/or feed-through lugs for feed through feeders.
- G. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for poles; UL listed. Predrill bus for bolt-on breakers.
 - 1. Type SWD for lighting circuits.
 - 2. Type HACR for air conditioning equipment circuits.
 - 3. Class A ground fault interrupter circuit breakers where scheduled.
 - 4. Class B ground fault equipment protection circuit breakers for heat trace and other circuits as required by Code. Provide shunt trip circuit breakers where scheduled; provide wiring to remote trip switch/contacts as indicated on Drawings.
 - 5. Do not use tandem circuit breakers.
 - 6. Combination AFCI Breaker: UL 1699 compliant. Integral 30mA GFCI trip. Manual test button for AFCI mechanism. Self-testing, tripping if AFCI module fails.
- H. Accessories: Provide where indicated: shunt trip, arc-fault circuit interrupter (AFCI), Class A ground fault circuit interrupter (GFCI), auxiliary switch and alarm switch.
- I. Cabinet Front: Provide flush or surface mounting as shown on the schedules, drawings, or otherwise noted. Cabinet front with concealed hinged front cover door-in-door construction, metal directory frame with heavy clear plastic protector, flush lift latch and lock, two keys per panel all keyed alike.
- J. Provide boxes with removable blank end walls and interior mounting studs. Provide interior support bracket for ease of interior installation.
- K. Furnish surface mounted cabinet boxes without knockouts.
 - 1. Minimum Integrated Short Circuit Rating:
 - a. 10,000 amperes symmetrical for 240 V panelboards.
 - b. 14,000 amperes symmetrical for 480 V panelboards.
 - c. Minimum rating as indicated on the Drawings or Panel Schedules.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install panelboards in accordance with NEMA PB 1.1, NECA 1 and manufacturers installation instructions.
- B. Install panelboards level and plumb. Install recessed panelboards flush with wall finishes.
- C. Height: 6-feet 6-inches to top of panelboard; install panelboards taller than 6-feet 6-inches with bottom no more than 4-inches (100 mm) above floor.
- D. Provide filler plates for unused spaces in panelboards.
- E. Provide typed circuit directory for each branch circuit panelboard. Include all "spaces" and "spares." Revise directory to reflect circuiting changes and as-installed conditions. Use final Owner designated room names and numbers, and not designations shown on drawings.
- F. Provide engraved plastic nameplates per Section 26 05 53, Identification for Electrical Systems.
- G. Provide arc flash labels per Section 260573, Electrical Distribution System Studies.
- H. Provide 4 (qty), 3/4-inch spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
- I. Provide permanent identification number in or on panelboard dead-front adjacent to each breaker pole position. Horizontal centerline of numbers to correspond with centerline of circuit breaker pole position.
- J. Ground and bond panelboard enclosure per NEC.
- K. Paint:
 - 1. Standard factory finish unless noted otherwise.
 - 2. Panelboards located in finished interior areas in view of building occupants: paint to match adjacent wall surface. Color and paint preparation as specified by Architect. Covers to be painted off wall, then installed over dried, painted wall surface.
- L. Provide handle guards on each circuit supplying obviously constant loads such as fire alarm, security, lighting controls, refrigerators and freezers, fire protection, etc.
- M. Provide interior wiring diagram, neutral wiring diagram, UL label, and short circuit rating on interior or in booklet format inserted in sleeve inside panel cover.
- N. Verify available recessing depth and coordinate wall framing with other divisions.
- O. Maintain fire rating of wall where panels are installed flush in fire rated walls.
- P. Perform inspections and tests in accordance with manufacturer's requirements.
- Q. Thoroughly clean exterior and interior of each panelboard in accordance with manufacturer's installation instructions.
- R. Vacuum construction dust, dirt, and debris out of each panelboard.
- S. Where enclosure finish is damaged, touch up finish with matching paint in accordance with manufacturer's specifications and installation instructions.

3.2 PANELBOARDS INSTALLATION

- A. Breakers being added to existing panelboards: Coordinate breaker type and short circuit rating with existing panelboard. Breakers to match existing in manufacturer's type and AIC rating. Provide new typed circuit directory.

- B. Provide handle tie to branch circuit breakers of multiwire branch circuits for simultaneous disconnection of circuits. Handle tie will be identified for use with circuit breakers provided. Reconfigure assigned circuits as necessary so that circuit breakers associated with multiwire branch circuits are physically adjacent, record changes in panelboard schedules and circuiting plans for record drawings.
- C. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.
- D. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

**SECTION 262716
ELECTRICAL CABINETS AND ENCLOSURES**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Hinged Cover Enclosures
 - 2. Cabinets
 - 3. Terminal Blocks
 - 4. Accessories

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Division 26, Electrical, Hangers and Supports for Electrical Systems.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.
 - 3. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks; National Electrical Manufacturers Association.
 - 4. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
 - 2. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
 - 3. Cabinet Keys: Deliver to Owner in accordance with Division 01, General Requirements for maintenance materials.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Conform to requirements of NFPA 70.
 - 2. Products: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Hinged Cover Enclosures:
 - 1. Cooper B-Line
 - 2. Qube Corporation
 - 3. Robroy Industries
 - 4. Circle AW
 - 5. Hoffman
 - 6. Wiegmann
 - 7. Or approved equivalent.
- B. Cabinets:
 - 1. Hoffman
 - 2. Circle AW
 - 3. Cooper B-Line
 - 4. Or approved equivalent.
- C. Terminal Blocks:
 - 1. Allen-Bradley/Rockwell Automation
 - 2. Cooper Bussmann
 - 3. WECO Electrical Connectors Inc.
 - 4. Or approved equivalent.
- D. Accessories:
 - 1. Cooper B-Line
 - 2. Rob Roy
 - 3. Qube Corporation
 - 4. Or approved equivalent.

2.2 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250, Type 1 or 3R steel enclosure.
- B. Covers: Continuous hinge, held closed by flush latch operable by screwdriver, key, or thumb latch.
- C. Provide interior plywood panel for mounting terminal blocks and electrical components; finish with white enamel.
- D. Provide interior plywood or steel panel for mounting terminal blocks and electrical components; finish with white enamel.
- E. Enclosure Finish: Manufacturer's standard enamel.
- F. Keys: Provide two of each different key.

2.3 CABINETS

- A. Boxes: Galvanized Steel, Plastic, Fiberglass, or Stainless Steel.

- B. Box Size: 24 inches (600 mm) wide by 24-inches high by 6 inches (150 mm) deep.
- C. Box Size: As noted on drawings.
- D. Backboard: Provide 3/4-inch thick plywood backboard for mounting terminal blocks. Paint matte white.
- E. Fronts: Steel, flush or surface type with concealed trim clamps, door with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.
- F. Provide metal barriers to form separate compartments for wiring of different systems and voltages.
- G. Provide accessory feet for free-standing equipment.
- H. Keys: Provide two of each different key.

2.4 TERMINAL BLOCKS

- A. Terminal Blocks: NEMA ICS 4.
- B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
- D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.5 ACCESSORIES

- A. Plastic Raceway: Plastic channel with hinged or snap-on cover.
 - 1. Product:

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install securely, in a neat and workmanlike manner as specified in NECA 1.
- B. Install items per manufacturers written instructions and the requirements of the project.
- C. Cleaning:
 - 1. Clean electrical parts to remove conductive and harmful materials.
 - 2. Remove dirt and debris from enclosure.
 - 3. Clean finishes and touch up damage.

3.2 HINGED COVER ENCLOSURES

- A. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner under the provisions of Section 26 05 29, Hangers and Supports for Electrical Systems.

3.3 CABINETS

- A. Install cabinet fronts plumb.

3.4 TERMINAL BLOCKS

- A. Install terminal blocks securely in a neat and workmanlike manner as specified in NECA 1.

3.5 ACCESSORIES

- A. Install plastic raceways channel parallel to the structure per manufacturers written instructions.

END OF SECTION

SECTION 262726 WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included: Provision of materials, installation and testing of:
 - 1. Wall Switches
 - 2. Receptacles
 - 3. Finish Plates
 - 4. Wall Dimmers
 - 5. Surface Covers

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. UL 498, Attachment Plugs and Receptacles.
 - 2. UL 943, Ground Fault Circuit Interrupters (Class A GFCI).
 - 3. UL 1472, Standard for Solid State Dimming Controls.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Wall switches and Dimmers
 - 2. Receptacles
 - 3. Wall Plates
 - 4. In-Use Cover

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Wall Switches:
 - 1. Toggle Type Characteristics:

- a. Cooper AH1201
 - b. Hubbell HBL 1221
 - c. Leviton 1221
 - d. Pass & Seymour PS20AC1
 - e. Or approved equivalent.
2. Decorative AC Rocker Switch Characteristics:
- a. Cooper
 - b. Hubbell
 - c. Leviton
 - d. Pass and Seymour
 - e. Or approved equivalent.
- B. Receptacles:
1. Industrial Grade:
 - a. Cooper 5362
 - b. Hubbell HBL5362
 - c. Bryant FRY5362
 - d. Leviton 5362
 - e. Pass & Seymour 5362A
 - f. Or approved equivalent.
 2. Commercial Grade - 20 Amp:
 - a. Cooper 5362
 - b. Hubbell 5362
 - c. Bryant 5352
 - d. Leviton 5362S
 - e. Pass & Seymour 5362
 - f. Or approved equivalent.
 3. Commercial Grade - 15 Amp:
 - a. Cooper 5262
 - b. Hubbell 5262
 - c. Bryant 5252
 - d. Leviton 525
 - e. Pass & Seymour 5362
 - f. Or approved equivalent.
 4. Light Duty Commercial Grade:
 - a. 20 Amp:
 - 1) Hubbell BR20
 - 2) Bryant BRS20
 - 3) Or approved Equivalent.
 - b. 15 Amp:
 - 1) Hubbell BR15
 - 2) Bryant BRS15
 - 3) Or approved equivalent.
 - c. Decorative Type - 20 Amp:
 - 1) Cooper 6362
 - 2) Hubbell DR20
 - 3) Leviton 16342
 - 4) Pass & Seymour 26852
 - 5) Or approved equivalent.
 5. Ground Fault Circuit Interrupter (GFCI) Receptacle:
 - a. Hubbell GFR5362SB
 - b. Cooper WRVGF20
 - c. Pass & Seymour 2095TRWR
 - d. Or approved equivalent.
 6. Residential Grade Receptacles:
 - a. Tamper Resistant, 15 amp:
 - 1) Cooper TR270
 - 2) Hubbell RR15STR

- 3) Bryant RR15STR
 - 4) Leviton T5320
 - 5) Pass & Seymour 3232-TR
 - 6) Or approved equivalent.
 - b. Tamper Resistant Decora Style:
 - 1) Cooper TR1107
 - 2) Hubbell RRD15STR
 - 3) Bryant RRD15STR
 - 4) Leviton T5325
 - 5) Pass & Seymour 885-TR
 - 6) Or approved equivalent.
 - c. GFCI, 20 amp:
 - 1) Cooper TWRVGF20
 - 2) Hubbell GFTR20
 - 3) Pass & Seymour 2095TRWR
 - 4) Or approved equivalent.
 - d. AFCI, Tamper Resistant, 15 amp:
 - 1) Hubbell AFR15R
 - 2) Leviton AFTR-K
 - 3) or approved equivalent.
7. Federal Specification Grade Plug Load Control Duplex Receptacle:
- a. Half controlled, 20 amp:
 - 1) Pass & Seymour 26352CH
 - 2) Leviton 16352-1P
 - 3) Hubbell DR20C1
 - 4) Or approved equivalent.
 - b. Dual controlled, 20 amp:
 - 1) Pass & Seymour 26352CD
 - 2) Leviton 16352-2P
 - 3) Hubbell DR20C2
 - 4) Or approved equivalent.
- C. Finish Plates:
1. Bryant
 2. Cooper
 3. Hubbell
 4. Leviton
 5. Pass and Seymour
 6. Or approved equivalent.
- D. Wall Dimmers:
1. Lutron NT Series
 2. Or approved equivalent.
- E. Surface Covers:
1. Aluminum with Gasket, Blanks, Single Gang:
 - a. Bell 240-ALF
 - b. Carlon
 - c. Or approved equivalent.
 2. 2-Gang:
 - a. Bell 236-ALF
 - b. Carlon
 - c. Or approved equivalent.
 3. While-in-Use Weatherproof Cover:
 - a. UV Stabilized Polycarbonate Cover:
 - 1) Pass & Seymour
 - 2) Intermatic

- 3) Hubbell
- 4) Cooper
- 5) Or approved equivalent.
- b. Thermoplastic Cover:
 - 1) Leviton
 - 2) Hubbell
 - 3) Or approved equivalent.
- c. Die Cast Cover:
 - 1) Intermatic
 - 2) Hubbell
 - 3) Cooper
 - 4) Or approved equivalent.

F. Provide lighting switches and receptacles of common manufacturer and appearance.

2.2 WALL SWITCHES

- A. Characteristics: Toggle type, quiet acting, 20 amp, 120/277 volt, UL listed for motor loads up to 80 percent of rated amperage, extra heavy duty.
- B. Timer Switches: Digital time switch to automatically turn light off after set time. Adjustable time setting from five minutes to 12 hours. LCD to show time remaining. 20-amp/120 to 277 volt.
- C. Momentary Center Off: Toggle type, quiet acting, 20-amp/120/277 volt, double throw momentary contact, center off position.
- D. Pilot Light Switches: Lighted handle, toggle type, red unless noted otherwise, neon pilot lamp. Pilot lamp energized when load is energized. 20 amp/120, 208 and 277 volt.
- E. Lighted Handle Switches: Lighted handle, quiet acting, 20 amp, 120/277 volt, toggle type, red unless noted otherwise neon lamp. Lamp energized when load is not energized.
- F. Key Switches: 20 amp/120-277 volt, black key guide.
- G. Finish: White.

2.3 RECEPTACLES

- A. Duplex Receptacles Characteristics: Straight parallel blade, 125 volt, 2 pole, 3 wire grounding.
 - 1. Commercial Grade: Riveted. Back and side wired. Brass ground contact on steel strap. Nylon face and nylon base. 20 amp.
- B. Ground Fault Circuit Interrupter (GFCI) Receptacle: Feed through type, back-and-side wired, tamper-resistant, weather resistant self-testing, 20 amp, 125VAC.
- C. Residential Grade Receptacles:
 - 1. Tamper-Resistant Receptacle: 15 amp, 125VAC, complies with CEC requirements for tamper-resistant receptacles in dwelling units.
 - 2. Tamper-Resistant Receptacle (Decora Style): 15 amp, 125VAC, complies with CEC requirements for tamper-resistant receptacles in dwelling units.
 - 3. Tamper-Resistant USB Charging: 15 amp, 125 VAC, dual port charging 3 amp, 5 VDC. Complies with battery charging specification USB BC1.2 and Part 16 of the FCC Rules. Compatible with USB 1.1/2.0/3.0 devices.
 - 4. AFCI, Tamper Resistant Receptacle: 15 amp, 125VAC, complies with CEC requirements for arc fault and tamper resistant receptacles in dwelling units.
 - 5. GFCI Receptacle: 20 amp, 125VAC, GFCI-type, complies with CEC requirements for tamper and weather resistant receptacles in dwelling units.

- D. While-in-Use Weatherproof Cover: NEMA 3R when closed over energized plug. Vertical mount for duplex receptacle. Provide continuous use cover with cover capable of closing over energized cord cap with bottom aperture for cord exit.
 - 1. UV stabilized polycarbonate cover with closed cell neoprene foam gasket.
 - 2. Thermoplastic cover with closed cell neoprene gasket.
 - 3. Die cast cover with closed cell neoprene foam gasket: Capable of being locked closed to prevent tampering or unauthorized use.
- E. Specification Grade Plug Load Duplex Receptacle: 20A, 125V, Decora style duplex receptacle, straight blade, hot terminal split with 1 plug controlled, self grounding. Back and side wired.
- F. Special Purpose Receptacles: Reference Drawings for NEMA Standard Specification.
- G. Finish:
 - 1. Same exposed finish as switches.
 - 2. Receptacles installed in surface raceway to match raceway finish. See Section 260533, Raceways.

2.4 FINISH PLATES

- A. Finish Plates: Type 302 stainless steel. Smooth satin finish..
- B. Provide telephone/signal device plates; activated outlets to have coverplates to match modular jack.

2.5 WALL DIMMERS

- A. Provide wall dimmers compatible with type of load controlled (i.e. line voltage, low voltage, 2-wire, 3-wire, 0-10v). Finish to match wall switches. Size dimmers to accept connected load. Do not cut fins. Where dimmers are ganged together, provide a single multi gang coverplate.

2.6 SURFACE COVERS

- A. Material: Galvanized steel, 1/2-inch raised industrial type with openings appropriate for devices installed on surface receptacles.
- B. Cast Box and Extension Adaptors: Aluminum with gasket, blanks single gang or 2-gang.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. See Architectural elevations for location and mounting height of wiring devices. Review Architectural elevations prior to rough-in and contact Architect immediately if conflicts are found between Architectural and Electrical Drawings. Do not rough-in devices until conflicts are resolved.
- B. Install wiring devices and finish plates plumb with building lines, equipment cabinets and adjacent devices. Devices not plumb will be fixed at no additional cost to Owner.
- C. Orientation:
 - 1. Install wiring devices with long dimension oriented vertically at centerline height shown on drawings or as specified.
 - 2. Vertical Alignment: When more than one device is shown on drawings in close proximity to each other, but at different elevations, align devices on a common vertical center line for best appearance. Verify with Architect.
 - 3. Horizontal Alignment: When more than one device is shown on drawings in close proximity to each other with same elevation, align devices on a common horizontal center line for best appearance. Verify with Architect.

- D. Provide labeling per Section 26 05 53, Identification for Electrical Systems.
- E. Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

3.2 WALL SWITCHES INSTALLATION

- A. At time of substantial completion, replace those items which have been damaged.

3.3 RECEPTACLES INSTALLATION

- A. Upon installation, adhere to proper and cautious use of convenience receptacles. At time of substantial completion, replace those items which have been damaged, including those burned and scored by faulty receptacles or cord caps.
- B. GFCI Receptacles: One GFCI receptacle may not be used to provide GFCI protection to downstream duplex receptacles on the same branch circuit.

3.4 FINISH PLATES INSTALLATION

- A. Do not install items until finish painting is complete. Replace scratched and paint splattered finish plates and wiring devices.
- B. Provide orange coverplates on isolated ground receptacles.

3.5 WALL DIMMERS INSTALLATION

- A. Install per manufacturers recommendations and wiring diagrams.

3.6 SURFACE COVERS INSTALLATION

- A. Do not install items until finish painting is complete. Replace scratched and paint splattered finish plates and wiring devices.

END OF SECTION

SECTION 262800 OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Fuses
 - 2. Molded Case Circuit Breakers

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Product data and instantaneous let-through current curves and average melting time current curves for fuses supplied to project.
 - 2. Product data and time/current trip curves for circuit breakers supplied to project.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fuses:
 - 1. Bussmann
 - 2. Ferraz-Shawmut
 - 3. Littelfuse
 - 4. McGraw-Edison
 - 5. Or approved equivalent.
- B. Molded Case Circuit Breakers:
 - 1. Eaton Electrical
 - 2. General Electric
 - 3. Siemens

4. Schneider Electric/Square D
5. Or approved equivalent.

2.2 FUSES

- A. Characteristics:
 1. Dual element, time delay, current limiting, nonrenewable type, rejection feature.
 2. Combination Loads: UL Class RK1, RK5, or J, 1/10 to 600 amp. UL Class L, above 600 amps.
 3. Motor Loads: UL Class RK5, 1/10 to 600 amp.
 4. Fuse pullers for complete range of fuses.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. 1-, 2- or 3-pole bolt-on, single handle common trip, 600VAC or 250VAC as indicated on Drawings.
- B. Overcenter toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
- C. Calibrate for operation in 40 degrees C ambient temperature.
- D. 15 to 150 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.
- E. 151 to 400 Amp Breakers: Adjustable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.
- F. Greater than 401 Amp: Electronic trip type with adjustments for long-time, instantaneous, and short-time functions.
- G. Provide ground fault function for breakers greater than 800 amps where applied at 480 volts line-to-line; and where indicated on drawings.
- H. Combination AFCI Breaker: UL 1699 compliant. Integral 30mA GFCI trip. Manual test button for AFCI mechanism.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination:
 1. Obtain and review the submitted product data for equipment furnished by the Owner, and furnished under other Divisions of this contract, particularly under Divisions 22 and 23.
 2. Confirm the equipment nameplate maximum overcurrent protection (MOCP) and make accommodations and adjustments to overcurrent protective devices as necessary to coordinate with the nameplate rating.
- B. Install all items in accordance with manufacturers written instructions.

3.2 FUSES

- A. Fuses: For each class and ampere rating of fuse installed, provide the following quantities of spares for quantity of fuses installed:
 1. 0 to 24: Provide 6 spare.
 2. 25 to 48: Provide 9 spare.
 3. 49 and Above: Provide 12 spare.

3.3 MOLDED CASE CIRCUIT BREAKERS

- A. Provide testing of ground fault interrupting breakers.
- B. Provide circuit breakers, as specified and on Drawings, for installation in panelboards, individual enclosures or combination motor starters.
- C. Provide ground fault interrupter circuit breakers for equipment in damp or wet locations.
- D. Provide device on handle to lock breaker in "ON" position for breakers feeding time switches, night lights and similar circuits required to be continuously energized.
- E. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.
- F. Provide multi-pole branch circuit breakers for multiwire branch circuits for simultaneous disconnection of circuits.

END OF SECTION

SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Toggle Type Disconnect Switches
 - 2. Manual Motor Starters
 - 3. Safety Switches
 - 4. Enclosed Circuit Breakers

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Toggle Type Disconnect Switches:
 - 1. Cooper
 - 2. Hubbell
 - 3. Leviton
 - 4. Pass & Seymour
 - 5. Slater
 - 6. Or approved equivalent.
- B. Manual Motor Starters:
 - 1. Eaton Electrical
 - 2. General Electric
 - 3. Schneider Electric/Square D
 - 4. Or approved equivalent.

- C. Safety Switches:
 - 1. Eaton Electrical
 - 2. GE Industrial
 - 3. Schneider Electric/Square D
 - 4. Or approved equivalent.
- D. Enclosed Circuit Breakers:
 - 1. Eaton Electrical
 - 2. GE Industrial
 - 3. Schneider Electric/Square D
 - 4. Or approved equivalent.

2.2 TOGGLE TYPE DISCONNECT SWITCHES

- A. Rating: 120 volt, 1 or 2 pole, 20 amp, 1 hp maximum.
- B. Enclosure:
 - 1. NEMA 1: Dry locations/Indoors.
 - 2. NEMA 3R: Damp or wet locations/Outdoors.
- C. Handle lockable in 'off' position.

2.3 MANUAL MOTOR STARTERS

- A. Quick-Make, Quick-Break. Thermal overload protection. Device labeled with maximum voltage, current, and horsepower.
- B. Enclosure:
 - 1. NEMA 1: Dry locations/Indoors.
 - 2. NEMA 3R: Damp or wet locations/Outdoors.

2.4 SAFETY SWITCHES

- A. Heavy duty fusible type and non-fusible type (as indicated on drawings), dual rated, quick-make, quick-break with fuse rejection feature for use with Class R fuses only, unless other fuse type is specifically noted.
- B. Clearly marked for maximum voltage, current, and horsepower.
- C. Operable handle interlocked to prevent opening front cover with switch in 'on' position.
- D. Switches rated for maximum available fault current.
- E. Handle lockable in 'off' position.
- F. Enclosure:
 - 1. NEMA 1: Dry locations/Indoors.
 - 2. NEMA 3R: Damp or wet locations/Outdoors.

2.5 ENCLOSED CIRCUIT BREAKERS

- A. Molded case circuit breakers:
 - 1. 1-, 2-, or 3-pole bolt on, single-handle common trip, 250VAC as indicated on drawings.
 - 2. Overcenter toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
 - 3. Calibrate for operation in 40C ambient temperature.

4. 15 to 150 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.
 5. 151 to 400 Amp Breakers: Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.
 6. Greater than 401 Amp: Electronic trip type with adjustments for long-time, instantaneous, and short-time functions. Provide ground fault function for breakers greater than 400 amps.
 7. Provide handle mechanisms that are lockable in the open (off) position.
 8. Circuit breakers to have minimum symmetrical interrupting capacity as indicated on Drawings.
 9. Where protective devices are applied in series combination, such that the prospective available fault current exceeds the interrupting rating (AIR) of the downstream protective devices, such combinations to be UL recognized combinations. Electrical equipment using these UL recognized circuit breaker combinations to be clearly marked in accordance with NEC Section 240.86 and 110.22.
- B. Enclosure:
1. NEMA 1: Dry locations/Indoors.
 2. NEMA 3R: Damp or wet locations/outdoors.
- C. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Provide fuse rejection feature for Class R or J fuses up to 600 amp. Remove if circuit breaker type is used. Provide switches of 30 to 200 amp with plug-on line side connections.
- D. Fusible Switch Assemblies, 800 Amperes and Larger: Bolted pressure contact switches. Fuse Clips: Designed to accommodate Class L fuses. Provide with shunt-trip and ground fault capabilities. Remove if circuit breaker type is used.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Obtain and review the submitted product data for equipment furnished by the Owner, and furnished under other Divisions of this contract, particularly under Divisions 22 and 23.
- B. Confirm the equipment nameplate maximum overcurrent protection (MOCP) and make accommodations and adjustments to switches, fuses and circuit breakers as necessary to coordinate with the nameplate rating
- C. Install in accordance with manufacturer's instructions.
- D. Provide engraved nameplates per Section 26 05 53, Identification for Electrical Systems.
- E. Provide arc flash labels per Section 26 05 73, Electrical Distribution System Studies.
- F. Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.

3.2 TOGGLE TYPE DISCONNECT SWITCHES

- A. Install fuses in fusible disconnect switches. Coordinate fuse ampere rating with installed equipment. Do not provide fuses of lower ampere rating than motor starter thermal units.
- B. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- C. See General Installation Requirements above.

3.3 MANUAL MOTOR STARTERS

- A. Provide disconnecting means within sight of each motor controller and of each motor. Motor controller disconnecting means equipped with lock-out/tag-out padlock provisions do not require a disconnect switch at the controlled motor location. Locate disconnect means in view of and not inside of equipment, such that tools are not needed to remove covers to access the disconnecting means.
- B. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- C. See General Installation Requirements above.

3.4 SAFETY SWITCHES

- A. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- B. See General Installation Requirements above.

3.5 ENCLOSED CIRCUIT BREAKERS

- A. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
- B. See General Installation Requirements above.

END OF SECTION

SECTION 265100 LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Luminaires
 - 2. Lamps
 - 3. Lighting Poles
- B. Provide wiring for complete and operating lighting system.

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. NECA 500 - Commercial Lighting

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01 General Requirements.
- B. In addition, provide:
 - 1. Submit:
 - a. Luminaires: Include electrical ratings, dimensions, mounting, material, required clearances, terminations, wiring and connection diagrams, photometric data, diffusers, and louvers.
 - b. Lamps
 - c. Lighting Poles
 - 2. Submittal Cutsheets: Highlight, circle or otherwise graphically indicate which option(s) are being selected for the products submitted. Cutsheets that are not edited to indicate which products and options are submitted for this project or that list only catalog numbers to identify submitted options are not acceptable.
 - 3. Specified manufacturers are approved to submit bid. However, inclusion does not relieve manufacturer from supplying product as described.
 - 4. Provide the following operating and maintenance instructions as required by Section 26 00 00, Electrical Basic Requirements:
 - a. Luminaires
 - b. Lamps
 - c. Lighting Poles

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Provide luminaires acceptable to code authority for application and location installed.
 - 2. Comply with applicable ANSI standards.

3. Comply with applicable NEMA standards.
4. Provide luminaires and lampholders that comply with UL standards and have been listed and labeled for location and use indicated by a testing agency acceptable by the AHJ (e.g. UL, ETL, and the like).
5. Comply with CEC as applicable to installation and construction of luminaires.
6. Comply with fallout and retention requirements of CBC for diffusers, baffles, and louvers.
7. Provide similar lamps and ballasts from common manufacturer (e.g. all fluorescent lamps from Osram/Sylvania, and all MR lamps from Ushio) unless indicated otherwise in the Luminaire Schedule.

1.6 WARRANTY

- A. Warranty as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 1. Warranty: LED systems and complete luminaires must have manufacturer's warranty of a minimum of 5 years from date of substantial completion, including driver.

1.7 ADDITIONAL MATERIAL

- A. Furnish 2 percent extra lens or louvers for each size and type of fluorescent luminaire.
- B. Furnish 10 percent extra lamps for each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Luminaires:
 1. Reference description and manufacturers in Luminaire Schedule on Drawings.
 2. Or approved equivalent.
- B. Lamps:
 1. LED (Light Emitting Diode) Lamps:
 - a. Nichia
 - b. Gee
 - c. Osram Sylvania
 - d. GE Lumination
 - e. Or approved equivalent.
 2. Unless specific manufacturer not shown on this list is indicated on the Luminaire Schedule.
 3. Special types as indicated on Luminaire Schedule.
 4. Or approved equivalent.
- C. Lighting Poles:
 1. Reference description and manufacturers in Luminaire Schedule on Drawings.
 2. Or approved equivalent.

2.2 LUMINAIRES

- A. Luminaires: Reference description and manufacturers in Luminaire Schedule on drawings.
- B. Where recessed luminaires are installed in cavities intended to be insulated, provide IC rated luminaires or other code approved installation.
- C. UL label luminaires installed under canopies, roof or open porches, and similar damp or wet locations, as suitable for damp or wet location.

- D. Suspended luminaires: Provide minimum 24-inch adjustability in aircraft cable length where used.
- E. Recessed Luminaires: Frame compatible with ceiling material installed at particular luminaire location. Provide proper factory trim and frame for luminaire to fit location and ceiling material. Verify with Architectural Reflected Ceiling Plan prior to submittals.
- F. Finishes:
 - 1. Manufacturer's standard finish (unless otherwise indicated) over corrosion resistant primer.
 - 2. Interior Light Reflecting Finishes: White or specular finish with not less than 85 percent reflectance.
 - 3. Exterior Finishes: As detailed in luminaire schedule or on drawings. Refer cases of uncertain applicability to Architect for resolution prior to release for fabrication.
- G. Light Transmitting Components:
 - 1. Plastic diffusers, molded or extruded of 100 percent virgin acrylic.
 - 2. Prismatic acrylic, extruded, flat diffusers, 0.125-inch overall thickness, unless otherwise noted.

2.3 LAMPS

- A. Provide lamps for luminaires.
- B. Provide lamp catalogued for specified luminaire type.
- C. Incandescent Lamps: Not allowed unless noted in Luminaire Schedule.
- D. LED (Light Emitting Diode):
 - 1. LED manufacturer will include, but not be limited to, light source, luminaire, power supply and control interface with added components as needed for complete and functioning system.
 - a. Comply with ANSI chromaticity standard for classifications of color temperature. See luminaire schedule for specified LED lamp color and color temperature. UL or ETL listed and labeled.
 - b. Luminaire testing per IESNA LM-79 and LM-80 procedures.
 - c. Lamp life for white LEDs: 50,000 plus hours with lamp failure occurring when LED produces 70 percent of initial rated lumens.
 - d. Lamp life for color LEDs: 30,000 plus hours with lamp failure occurring when LED produces 50 percent of its initial rated lumens.
 - e. LED Drivers: reverse polarity protection, open circuit protection, require no minimum load. Minimum 80 percent efficiency. Class A noise rating.
 - f. Dimming: LED system capable of full and continuous dimming.
 - 2. Special types as indicated in luminaire schedule.

2.4 LIGHTING POLES

- A. Provide direct buried exterior light poles with concrete bases or direct buried which are structurally supportive of pole under design loading.
- B. Provide exterior poles clean and scratch free with base bolt covers to match pole and luminaire finish.
- C. Provide poles and pole bases rated for a minimum of 100 MPH, unless otherwise noted. Wind EPA loading for quantity and type of luminaire it supports with a 1.3 gust factor.
- D. Provide poles with gasketed handholes, stainless steel tamper resistant hardware, anchor bolts and ground lugs.
- E. Description:
 - 1. Manufacturer and Model: See luminaire schedules.
 - 2. Material: Steel, Aluminum, Treated wood, or Concrete.
 - 3. Shape: Tapered round

4. Finish: Galvanized, Primed for field painting, or Anodized
5. Base: Embedded, Anchor, or Transformer.
6. Accessories: Slipfitter and Mast Arms.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install per manufacturers written installation instructions and requirements.
- B. Install luminaires securely, in neat and workmanlike manner.
- C. Install luminaires of types indicated where shown and at indicated heights in accordance with manufacturer's written instructions and with recognized industry practices to ensure that luminaires comply with requirements and serve intended purposes.
- D. Wiring:
 1. Recessed luminaires to be installed using flexible metallic conduit with luminaire conductors spliced to branch circuit conductors in nearby accessible junction box over ceiling. Junction box fastened to building structural member within 6-feet of luminaire.
 2. Luminaires for lift out and removal from ceiling pattern without disconnecting conductors or defacing ceiling materials.
 3. Flexible connections where permitted to exposed luminaires; neat and straight, without excess slack, attached to support device.
 4. Install junction box, flexible conduit and high temperature insulated conductors for through wiring of recessed luminaires.
- E. Relamp luminaires which have failed lamps at substantial completion.
- F. Replace ballasts deemed as excessively noisy by Architect, Engineer, or Owner.
- G. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
- H. Support luminaires larger than 2- by 4-foot size independent of ceiling framing.
- I. Locate recessed ceiling luminaires as indicated on architectural reflected ceiling plan.
- J. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- K. Exposed Grid Ceilings:
 1. Support surface mounted luminaires in grid ceiling directly from building structure.
 2. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires.
 3. Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.
- L. Install recessed luminaires to permit removal from below.
- M. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- N. Install clips to secure recessed grid-supported luminaires in place.
- O. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Architectural Drawings.
- P. Install accessories furnished with each luminaire.

- Q. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- R. Bond products and metal accessories to branch circuit equipment grounding conductor.
- S. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.
- T. Where manufactured wiring assemblies are used, insure that wiring assembly manufacturer sends components to appropriate luminaire manufacturer for respective installation of proper components.
- U. Coordination:
 - 1. Coordination of Conditions: Coordinate ceiling construction, recessing depth and other construction details prior to ordering luminaires for shipment. Refer cases of uncertain applicability to Architect for resolution prior to release of luminaires for shipment. Where luminaires supplied do not match ceiling construction, replace luminaires at no cost to Owner.
 - 2. Electrical drawings are schematic, identifying quantity and type of luminaires used and their approximate location, but are not to be used for dimensional purposes. Reference architectural drawings for exact locations, including mounting heights.
 - 3. Provide lighting indicated on drawings with luminaire of the type designated and appropriate for location.
 - 4. Provide fluorescent and HID luminaires with ballast compatible to lighting control system as shown in drawings and as specified.
 - 5. Where remote ballasts and drivers are required, ensure adequate accessibility to ballast. Upsize conductors between luminaire and ballast to accommodate voltage drop.
- V. Field Quality Control:
 - 1. Perform field inspection in accordance with Division 01, General Requirements.
 - 2. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- W. Cleaning:
 - 1. Clean electrical parts to remove conductive and deleterious materials.
 - 2. Remove dirt and debris from enclosures.
 - 3. Clean paint splatters, dirt, dust, fingerprints, and debris from luminaires.
 - 4. Clean photometric control surfaces as recommended by manufacturer.
 - 5. Clean finishes and touch up damaged finishes per by manufacturer's instructions.
- X. Demonstrate luminaire operation for minimum of two hours.

3.2 LUMINAIRES

- A. Install per manufacturers written installation instructions and requirements.
- B. Align, mount and level luminaires uniformly. Use ball hangers for suspended stem mounted luminaires.
- C. Avoid interference with and provide clearance from equipment. Where indicated locations for luminaires conflict with locations for equipment, change locations for luminaire by minimum distance necessary as directed by Architect.
- D. Suspended Luminaires: Mounting heights indicate clearances between bottom of luminaire and finished floors.
- E. Emergency Egress Luminaires: Provide unswitched circuit for battery charging and autotransfer circuiting for exit signs and luminaires with integral batteries. Where test switch cannot be integral to luminaire, mount remote test switch flush-to-ceiling and adjacent to egress luminaire.
- F. Interior Luminaire Supports:

1. Support Luminaires: Anchor supports to structural slab or to structural members within a partition, or above a suspended ceiling.
 2. Maintain luminaire positions after cleaning and relamping.
 3. Support luminaires without causing ceiling or partition to deflect.
 4. Provide mounting supports for recessed and pendant mounted luminaires as required by IBC.
- G. Adjusting:
1. Aim and adjust luminaires as indicated.
 2. Focus and adjust floodlights, spotlights and other adjustable luminaires, with Architect, at such time of day or night as required.
 3. Align luminaires that are not straight and parallel/perpendicular to structure.
 4. Position exit sign directional arrows as indicated.
- H. Demonstrate luminaire operation for minimum of two hours.

3.3 LAMPS

- A. Install lamps per manufacturers installation instructions and requirements.
- B. Reference General Installation Requirements above.

3.4 LIGHTING POLES

- A. Install lighting poles per manufacturers installation instructions and requirements.
- B. Exterior Luminaire Supports:
 1. Provide concrete bases for pole-mounted lighting units and bollard lights at locations shown on site plan drawing(s). Provide concrete bases as shown on drawings or as recommended by manufacturer if not shown on drawings. Minimum base height above grade in automobile areas is 30-inches. Install luminaire poles plumb.
 2. Install pole concrete bases in undisturbed or compacted soil. Where soil is disturbed provide backfill and compaction per Division 31, Earthwork requirements.

END OF SECTION

SECTION 270000 COMMUNICATIONS BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in 27 00 00, Communications Basic Requirements applies to Division 27, Communications work to provide materials, labor, tools, and other services to provide IT data outlets in the wall. The scope shall be limited to faceplates, jacks, backboxes, conduit and horizontal cabling only. Communications project scope shall stop at the wall outlets.
- B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. Definitions:
 - 1. Provide: To furnish and install, complete and ready for intended use.
 - 2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
 - 3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
 - 4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent," substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
 - 5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.
 - 6. Entrance Facility (EF): Area or location that contains entrance point (demarcation) cable and associated equipment for telecommunication services entering the building.
 - 7. Equipment Room (ER): Area or location that contains backbone cabling associated with interbuilding cable or cable that connects buildings together in a campus environment. ERs may contain Main Cross-Connects, Intermediate Cross-Connects, Horizontal Cross-Connects, and Telecommunication Rooms.
 - 8. Main Cross-Connect (MC): Area or location that contains telecommunications equipment for connecting backbone cable to/from Intermediate Cross-Connects and Horizontal Cross-Connects. Active telecommunications equipment will often be contained in this area to serve as the telecommunications hub or headend. Backbone cable from Local Exchange Carrier's point of demarcation will connect to building backbone cable or active telecommunications equipment at this location.
 - 9. Intermediate Cross-Connect (IC): Area or location that contains telecommunications equipment for connecting backbone cable from the MC to backbone cable distributing to one or many Horizontal Cross-Connects. This location may contain active telecommunications equipment.
 - 10. Horizontal Cross-Connect (HC): Area or location that contains telecommunications equipment, cable terminations and cross-connect wiring. HC is the recognized connection point between backbone and horizontal pathway facilities.
 - 11. Telecommunications Room (TR): Area or location containing telecommunications equipment, cable terminations and cross-connect wiring. Three applications serviced by TRs are horizontal cable connections, backbone system interconnection and entrance facilities. The TR provides facilities (space, power, grounding, etc.) for housing telecommunications equipment. TR may contain a MC, IC or HC and a demarcation point or an interbuilding entrance facility.

12. Interbuilding Cable: Backbone cable associated with connecting buildings together in a multibuilding or campus environment.
13. Intrabuilding Cable: Backbone cable associated with connecting Entrance Facility, Equipment Rooms, Main Cross-Connects, Intermediate Cross-Connects, Horizontal Cross-Connects, and Telecommunication Rooms together on single floor or multifloor building.

1.2 RELATED SECTIONS

- A. Contents of Section applies to Division 27, Communications Contract Documents.
- B. Related Work:
 1. Additional conditions apply to this Division including, but not limited to:
 - a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - b. Drawings
 - c. Addenda
 - d. Owner/Architect Agreement
 - e. Owner/Contractor Agreement
 - f. Codes, Standards, Public Ordinances and Permits

1.3 REFERENCES AND STANDARDS

- A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 27, Communications Sections and those listed in this Section.
- B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 1. State of California:
 - a. CBC California Building Code
 - b. CEC California Electrical Code
 - c. CEC T24 California Energy Code Title 24
 - d. CFC California Fire Code
 - e. CMC California Mechanical Code
 - f. CPC California Plumbing Code
 - g. CSFM California State Fire Marshal
 - h. DSA Division of State Architect Regulations and Requirements
- C. Reference standards and guidelines include but are not limited to the latest adopted editions from:
 1. ABA Architectural Barriers Act
 2. ADA Americans with Disabilities Act
 3. ANSI American National Standards Institute
 4. ANSI/TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
 5. ANSI/TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
 6. ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and
 7. ANSI/TIA-568-C.3 Optical Fiber Cabling Components Standard. Commercial
 8. ANSI/TIA-569-B Commercial Building Standard for Telecommunications
 9. ANSI/TIA-570-B Residential Telecommunications Infrastructure
 10. ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers
 11. ANSI/TIA/EIA-606-A Administration Standard for Commercial Telecommunications
 12. ANSI-J-STD-607-A Commercial Building Grounding (Earthing) and Bonding
 13. APWA American Public Works Association
 14. ASCE American Society of Civil Engineers
 15. ASHRAE Guideline 0, the Commissioning Process
 16. ASTM ASTM International

17. BICSI	Building Industry Consulting Service International
18. BICSI TDMM	Telecommunications Distribution Methods Manual
19. BICSI ESSDRM	Electronic Safety & Security Design Reference Manual
20. BICSI AVDRM	AV Design Reference Manual
21. CFR	Code of Federal Regulations
22. CSA	CSA International
23. EIA	Electronic Industries Association
24. EPA	Environmental Protection Agency
25. ETL	Electrical Testing Laboratories
26. FCC	Federal Communications Division
27. FDA	Food & Drug Administration
28. FM	FM Global
29. IBC	International Building Code
30. IEC	International Electrotechnical Commission
31. IEEE	Institute of Electrical and Electronics Engineers
32. ISO	International Organization for Standardization
33. MSS	Manufacturers Standardization Society
34. NEC	National Electric Code
35. NEMA	National Electrical Manufacturers Association
36. OSHA	Occupational Safety and Health Administration
37. TIA	Telecommunications Industry Association
38. UBC	Uniform Building Code
39. UL	Underwriters Laboratories Inc.
40. USDA	United States Department of Agriculture

- D. See Division 27, Communications individual Sections for additional references.
- E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.
- F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

1.4 SUBMITTALS

- A. See Division 01, General Requirements for Submittal Procedures.
- B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.
- C. In addition:
 1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
 2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent

- piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
3. Product Data: Provide manufacturer's descriptive literature for products specified in Division 27, Communications Sections.
 4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the specifications and Drawings.
 - a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
 - b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 27, Communications specification Sections for specific items required in product data submittal outside of these requirements.
 - c. See Division 27, Communications individual Sections for additional submittal requirements outside of these requirements.
 5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
 6. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
 7. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 27, Communications Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
 8. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
 9. Substitutions and Variation from Basis of Design:
 - a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
 - b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals." For any product marked "or approved equivalent," a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.
 10. Shop Drawings:
 - a. Provide coordinated Shop Drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 27, Communications specification Sections for additional requirements for Shop Drawings outside of these requirements.
 - b. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
 11. Samples: Provide samples when requested by individual Sections.

12. Resubmission Requirements:
 - a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Changes made for the resubmittal will be indicated in a cover letter with reference to page(s) changed and will reference response to comment. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
 - b. Resubmit for review until review indicates no exceptions taken, or "make corrections as noted."
 - c. When submitting Drawings for Engineers re-review, clearly indicate changes on Drawings and "cloud" any revisions. Submit a list describing each change.
13. Operation and Maintenance Manuals, Owners Instructions:
 - a. Submit, at one time, one bound copy and electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
 - 1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
 - 2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: batteries, lamp lenses, speakers and filters.
 - 3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Sections.
 - 4) Include product certificates of warranties and guarantees.
 - 5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and subassemblies.
 - 6) Include copy of burn-in and test reports specific to each piece of equipment.
 - 7) Include copy of software/appliance programming.
 - 8) Include commissioning reports.
 - 9) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
 - b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Submit copy of material used for Owner instruction. Field instruction per Section 27 00 00, Communications Basic Requirements Article titled "Demonstration."
 - c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.
14. Record Drawings:
 - a. Maintain at site at least one set of drawings for recording "as-constructed" conditions. Indicate on Drawings changes to original documents by referencing revision document, and include buried elements, location of conduit, and location of concealed communication items. Include items changed by field orders, supplemental instructions, and constructed conditions.
 - b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
 - c. At completion of project, input changes to original project on CAD Drawings and make one set of black-line Drawings created from CAD Files in version/release equal to Contract Drawings. Submit CAD disk and Drawings upon substantial completion.

- d. Invert elevations and dimensioned locations for incoming utilities and site raceways below grade extending to 5-feet outside building line.
- e. See Division 27, Communications individual Sections for additional items to include in Record Drawings.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed to conform with all local, state, federal and other applicable laws and regulation.
- B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., conduit) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.
- C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- E. Provide products which are UL listed.
- F. Contractor Qualifications:
 - 1. Minimum of five years experience in the design, installation, testing and maintenance of communications systems.
 - 2. Must employ at least one full time BICSI certified Registered Communications Distribution Designer (RCDD) who is involved in reviewing work performed by contractor on this project.
 - 3. Maintain a local service facility which stocks spare devices and/or components for servicing systems.
 - 4. Have performed successful installation and maintenance of at least three projects similar in scope and size. Be able to provide project references for these three projects, including scope of Work, project type, Owner/user contact name and telephone number.
 - 5. The contractor selected for this project must be certified by the manufacturer of the approved products and utilize these components for completion of work.

1.6 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.
- B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.7 COORDINATION DOCUMENTS

- A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, lights, cable trays and electrical services with architectural and structural requirements, and other trades (including ceiling suspension and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.

- B. Advise Architect in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
- C. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.
- D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide like items from one manufacturer, including but not limited to jacks, patch panels, equipment connection cords and wall plates.

2.2 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities. Equipment/fixture supplier is responsible for obtaining state, county, and city acceptance on equipment/fixture not UL approved or not listed for installation.
- B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
- C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- D. Hazardous Materials:
 - 1. Comply with local, State of California, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
 - 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements and 08. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 - 1. Provide flush mounting access panels for service of systems, equipment and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
 - a. Ceiling access panels to be minimum of 24-inch by 24-inch required and approved size.
 - b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
 - c. Provide two keys for each set of keyed cylinder type locks.
 - d. Manufacturers and Models:
 - 1) Drywall: Karp KDW.
 - 2) Plaster: Karp DSC-214PL.
 - 3) Masonry: Karp DSC-214M.
 - 4) 2 hour rated: Karp KPF-350FR.
 - 5) Manufacturers: Karp, Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.
- B. Install equipment requiring access (i.e., amplifiers, taps, zone controllers, volume controls, and storage devices) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.
- C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.
- D. Earthwork:
 - 1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 - a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork divisions. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
 - b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
 - c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.
- E. Firestopping:
 - 1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 - a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- F. Plenums:
 - 1. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Division 13, Special Construction, Section 27 00 00, Communications Basic Requirements and individual Division 27 Communications Sections.
- B. Equipment Importance Factor: 1.0.
- C. General:
 - 1. Confirm Building Risk Category and Seismic Design Category with Architect.
 - 2. Earthquake resistant designs for Communications (Division 27) equipment and distribution, i.e. cabinets and racks, ceiling assemblies, raceways, ladder racking, etc. conform to regulations of jurisdiction having authority.

3. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
4. Provide stamped Shop Drawings from licensed structural engineer of seismic bracing and seismic movement assemblies for cabinets, racks, major equipment and overhead raceways. Engineer to design and provide stamped Shop Drawings cabinets, racks, major equipment and overhead raceway. Submit Shop Drawings along with equipment submittals.
5. Provide stamped Shop Drawings from licensed structural engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.
6. Equipment:
 - a. Provide means to prohibit excessive motion of equipment during earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.
- B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
 1. Underground conduit installation prior to backfilling.
 2. Prior to ceiling cover/installation.
 3. When main systems, or portions of, are being tested and ready for inspection by AHJ.
- C. Final Punch:
 1. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.4 CONTINUITY OF SERVICE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 1. During remodeling or addition to existing structures, or addition of a structure to existing structure, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
 2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new wiring to point of connection.
 3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
 - a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 4. Organize work to minimize duration of power interruption.

3.5 CUTTING AND PATCHING

- A. Confirm Cutting and Patching Requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 1. Proposed floor cutting/core drilling/sleeve locations to be approved by project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit

scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).

2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

- A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

3.7 DELIVERY, STORAGE AND HANDLING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.
 2. Protect all equipment and conduit to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.

3.8 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.
- B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.
- C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.9 CLEANING

- A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.
- B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

- A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.
- B. Install equipment and devices in accordance with manufacturer's installation instructions, plumb and level and firmly secured to mounting surfaces. Maintain manufacturer's recommended clearances.
- C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test operation and demonstrate compliance with requirements. Replace damaged or malfunctioning equipment.
- D. Provide miscellaneous supports/metals required for installation of equipment.

3.11 PAINTING

- A. Confirm Painting requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 - 1. Ferrous Metal: After completion of communications work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in telecommunications rooms, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
 - 2. In a telecommunications room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
 - 3. See individual equipment Specifications for other painting.
 - 4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
 - 5. Conduit: Clean, primer coat and paint interior conduit exposed in finished areas with two coats paint suitable for metallic surfaces. Color selected by Architect.
 - 6. Covers: Covers such as manholes, vaults and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

- A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 - 1. Coordinate locations/sizes of access panels with Architect prior to work.

3.13 DEMOLITION

- A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 - 1. Scope:

- a. It is the intent of these documents to provide necessary information and adjustments to communications systems required to meet code and accommodate installation of new work.
 - b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
 - c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work. Compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.
 3. Unless specifically indicated on Drawings, remove exposed, unused raceways behind finished surfaces (floor, walls, ceilings, etc.). Cap raceways and patch surfaces to match surrounding finish.
 4. Unless specifically indicated on Drawings, remove unused equipment, electrical boxes, fittings and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).
 5. Examination:
 - a. Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to locate and preserve utilities. Replace damaged items with new material to match existing.
 - b. Verify that abandoned wiring and equipment serve only abandoned facilities.
 - c. Demolition Drawings are based on casual field observation and existing record documents.
 - 1) Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish work.
 - 2) Verify location and number of communications outlets, racks, panels, etc. in field.
 - d. Report discrepancies to Architect before disturbing existing installation.
 6. Promptly notify Owner if utilities are found which are not shown on Drawings.
 7. Execution:
 - a. Remove existing connectors, backboxes, wall plates and other communications equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless shown as retained or relocated on Drawings.
 - b. Provide temporary wiring and connections to maintain communications continuity of existing systems during construction. Remove or relocate communications boxes, conduit, wiring, equipment, and the like, as encountered in removed or remodeled areas in existing construction affected by this work.
 - c. Remove and restore cable which serves usable existing outlets clear of construction or demolition.
 - d. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing communications equipment which is being retained, provide new conduit and cable to bypass abandoned outlets.
 - e. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and cable to reroute clear of construction or demolition and maintain service to existing equipment. If these are conduits which require a new cable home run, e.g. telecom cable, request clarification from Architect or Engineer prior to proceeding with demo.
 - f. Extend cable slack and devices in existing walls to be furred out.
 - g. Remove abandoned cable to originating telecom room.
 - h. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
 - i. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
 - j. Disconnect and remove abandoned panelboards and distribution equipment.

- k. Maintain access to existing communications installations which remain active. Modify installation or provide access panel as appropriate.
 - l. Existing communications outlets and devices are indicated on technology demolition plans. Verify exact location and number of existing communications outlets and devices in field. Only partial existing communications shown. Locations of items shown on Drawings as existing are partially based on Record and other Drawings which may contain errors. Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish intent of Contract Documents.
 - m. Remove abandoned cable to leave site clean.
- B. Existing Communication Systems: Maintain existing systems in service until new system is complete and ready for service. Disable system only to make switchovers and connections.
- 1. Notify Owner at least 30 working days before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.14 ACCEPTANCE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
- 1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
 - a. Testing Reports
 - b. Cleaning
 - c. Operation and Maintenance Manuals
 - d. Training of Operating Personnel
 - e. Record Drawings
 - f. Warranty and Guaranty Certificates, including extended manufacturer's warranties.
 - g. Start-up/test Documents and Commissioning Reports

3.15 FIELD QUALITY CONTROL

- A. Confirm Field Quality Control requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.
- B. Tests:
- 1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in Operation and Maintenance Manuals.
 - 2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

END OF SECTION

**SECTION 270528
PATHWAYS FOR COMMUNICATIONS SYSTEMS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Raceway
 - 2. Electrical Metallic Tubing and Fittings
 - 3. Telecommunications Outlet Boxes
 - 4. Pull Boxes
- B. This Section specifies the requirements to provide communications conduit raceways, boxes, cable trays, innerduct and fittings.

1.2 RELATED SECTIONS

- A. Contents of Division 27, Communications and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Plan drawings showing completions and as-built corrections which indicate type, size, placement, routing and/or length for raceway and cable tray components; e.g., manholes, handholes, conduit, wireway, boxes, enclosures, etc.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.7 DEFINITIONS

- A. Cabinet: A freestanding floor-mounted modular enclosure designed to house and protect rack-mounted electronic equipment.
- B. Conduit: Round raceway.
- C. Conduit Body: Separate portion of a conduit or tubing system that provides access through removable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system.
- D. Pull Box Enclosure: Box with a cover installed in one or more runs of raceway to facilitate pulling conductors through the raceway system. There are no openings in the cover.

- E. Raceway: Enclosed channel designed expressly for holding wires or cables. Metal or insulating material and the term includes conduit, tubing, wireways, underfloor raceways and surface raceways; does not include cable tray.
- F. Surface Raceway: Surface-mounted metal channel or plastic duct with snap-in removable covers for housing and protecting electrical wires and cables. Raceway and fittings are designed so sections can be electrically and mechanically coupled together without subjecting cables to abrasion.
- G. Wire Basket Runway Systems: Includes, but are not limited to straight sections of type wire basket runway cable trays, bends, tees, elbows, drop-outs, supports and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Raceway:
 - 1. Koppers Bitumastic
 - 2. Scotchwrap
 - 3. Or approved equivalent.
- B. Electrical Metallic Tubing and Fittings:
 - 1. Allied Tube and Conduit
 - 2. Wheatland Tube
 - 3. Appleton
 - 4. Or approved equivalent.
- C. Telecommunications Outlet Boxes:
 - 1. Randl
 - 2. Or approved equivalent.
- D. Pull Boxes:
 - 1. Hoffman
 - 2. Oldcastle (concrete)
 - 3. Or approved equivalent.

2.2 RACEWAYS

- A. Raceways: Labeled and/or listed as acceptable to the AHJ as suitable for the use intended.
- B. Table 1: Product Identification:

Product Designation	Product Type
RGS	Rigid Galvanized Steel
CRS	PVC Externally Coated RGS
EMT	Galvanized Steel Tubing
PVC	Polyvinylchloride Conduit
LMC	Liquidtight Metal Conduit
LNC	Liquidtight Nonmetal Conduit

- C. The product identification codes used for the Communications Raceways and Boxes in Part 2, Products, are summarized in Table 1.
- D. Bitumastic material or plastic tape.

2.3 ELECTRICAL METALLIC TUBING AND FITTINGS

- A. Type EMT: Electrogalvanized steel tubing.
- B. Fittings and Conduit Bodies:
 - 1. In-line straight-through steel or malleable iron fittings and Type C conduit bodies only; do not use bends or tees, e.g. Lbs.
 - 2. Wet Areas: Steel compression-type couplings and nipples.
 - 3. Dry Areas: Set screw-type couplings and nipples.
 - 4. Bonding Locknuts:
 - a. Malleable iron with set screws and lug screws.
 - b. Insulated Bushing: Malleable iron with integral insulated throat, rated for 150C.
 - c. Bonding and Grounding Bushing: Malleable iron with integral insulated throat, rated for 150C, with solderless lugs or lug screws.

2.4 TELECOMMUNICATIONS OUTLET BOXES

- A. Sheet Metal Outlet Boxes: Minimum 4-inch square by 2-1/8-inch deep, galvanized steel for use with single- or double-gang plaster rings.
- B. Five Square Outlet Boxes: Minimum 5-inch square by 2-7/8-inch deep with built-in cable management for use with single- or double-gang plaster rings. Randl P/N T-55017 approved.
- C. Nonmetallic Outlet Boxes: Minimum 4-inch square by 2-1/2-inch-deep. Provide gasketed, watertight single- or double-gang cover.
- D. Plaster Rings: Single- or Double-gang as shown on the Drawings.

2.5 PULL BOXES

- A. Construction: NEMA Standard No. 250. Type 1 galvanized steel enclosures designed for use as junction boxes and pull boxes with flat screw-applied covers, with or without knockouts and gray enamel finish.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

- A. Workmanship:
 - 1. Provide, condition, apply, install, connect and test manufactured products, materials, equipment and components in accordance with the manufacturer's specifications and printed instructions.
 - 2. The installation of system components to be carried out under the direction of qualified personnel. Appearance to be considered as important as mechanical and electrical efficiency. Workmanship to meet or exceed industry standards.
 - 3. Place support for framing, raceways, cable trays, backboards, equipment racks and cabinets.
- B. Protection During Construction: Protect products from the effects of moisture, corrosion and physical damage during construction. Except during installation activity in a section, keep openings in conduit, tubing and wireway capped with manufactured seals during construction.
- C. Concrete Sleeves: Conduits routed perpendicular through floors, walls, or other concrete structures to pass through cast-in-place conduit sleeve openings wherever possible, or appropriate size holes to be bored to accommodate the installation of conduit sleeves. The size and location of the holes to not impair the structure's integrity.
 - 1. Concrete Boring: Bore a hole in the concrete with a diameter of 1/2 to 1-inch larger than the conduit sleeve to be installed. Grout around the conduit sleeve and finish to match existing surroundings.

2. Conduits that rise vertically through a slab to be stubbed 6-inches above the floor and capped pending future use.
- D. Drywall/Gypsum Board Sleeves: Install insulating throat bushings on both ends of conduit sleeves placed in fire-rated walls using drywall construction.
 - E. Where conduit enters a structure through a concrete roof or membrane waterproofed wall or floor:
 1. Provide a watertight seal.
 2. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
 3. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
 4. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
 - F. Provide continuous sleeving through walls, floors and ceilings separating each telecom outlet from its respective MER/TR room, using sleeve conduit size as required per Standards. Restore penetrations through rated assemblies to original fire rating per NFPA and local codes.
 - G. Locate sleeves as shown on Drawings. Where sleeves are not shown on Drawings, install sleeves above suspended ceilings and locate to minimize length of pathway for future cable from telecom outlet to MER/TR rooms.
 - H. Where sleeves are routed between rooms with floating ceilings, extend conduits horizontally 2-feet over edge of floating ceiling to avoid exposed cabling from being seen at floor level.
 - I. Make floor penetrations no more than 4-inches from wall. Install conduit stubs to extend 4-inches from floor base. Cap conduits for protection.
 - J. Provide removable heat-expanding pillows at fire barrier penetrations as specified in Firestopping section and described as Firestop Material Type 7 (indicated as FSM-7).
 - K. Grounding: Provide ground connections and bonding continuity between raceway and wire basket runway sections, boxes, enclosures, cabinets and fittings as required per code and industry standard.
 - L. Provide plenum rated products, components and accessories for installation in plenums.

3.2 RACEWAYS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's written instructions and recommendations.
- C. Raceway Identification Banding:
 1. Degrease and clean surfaces to receive tape labels.
 2. Exposed conduits and wireway, including raceways above lay-in or accessible ceilings, together with associated pull boxes to be banded at intervals of not over 10-feet and at direction changes. Two-band identification to be different contrasting colors as follows:

Raceway Use	Color
Grounding	Green
Telecom/datacom	Yellow
CCTV	White
Building monitoring and security	Grey

3.3 ELECTRICAL METALLIC TUBING AND FITTINGS

- A. Reference 3.01, General Installation Requirements.

B. Install per manufacturer's written instructions and recommendations.

C. Minimum Conduit Size:

1. 4-inch for underground applications unless otherwise indicated on the Drawings.
2. Size recessed conduits to surface raceway serving multiple data outlets as follows. Sizing is based on TIA/EIA 569-B for 28 percent conduit fill, assuming Category 5e cables (nominal outer diameter 0.24-inch) to each data outlet. Provide recessed backbox between surface raceway and recessed conduit sized for conduit.

1 to 6 cables	1-inch conduit
7 to 10 cables	1-1/4-inch conduit
11 to 15 cables	1-1/2-inch conduit
16 to 20 cables	2-inch conduit
Above 20 cables	Use multiple runs of conduit from surface raceway based on above table

D. Minimum Backbone Conduit Requirements: Install three 4-inch conduits from MER to each TR, unless otherwise noted on Drawings.

E. Conduit Type:

1. Install the following types of circular communications raceway in the locations listed unless otherwise indicated on the Drawings.
 - a. Interior Dry Locations, Exposed: EMT with set screw fittings.
 - b. Interior Dry Locations, Concealed (Not Embedded in Concrete): EMT with set screw fittings.
 - c. Interior Wet Locations: EMT with compression fittings.
 - d. Exterior, Exposed Including Roof: Rigid steel conduit.
 - e. Exterior, Underground: PVC Schedule 40 Conduit.
 - f. Concrete-Encased Duct Banks:
 - 1) PVC Schedule 40 conduit.
 - 2) Rigid steel conduit when additional protection is required.
 - g. Flexible Conduit (Interior Exposed):
 - 1) Liquidtight flexible metal conduit for use with copper cable.
 - 2) Liquidtight flexible nonmetallic conduit for use with fiber optic cable.

F. Conduit Bends and Sweeps:

1. Make changes in direction of communications conduit runs with sweeps of the longest possible radius.
2. Make sweeps in parallel or banked runs of conduits, 2-inches and larger in diameter, from the same center or centerline so that sweeps are parallel and of neat appearance.
3. Field-Made Bends and Sweeps:
 - a. Use an acceptable hickey or conduit-bending machine.
 - b. Do not heat metal raceways to facilitate bending.
 - c. Before installing 4-inch field-made sweeps in duct banks, pull a 3-1/2-inch diameter by 12-inch long mandrel through duct sections to verify circularity and sweep radius.
4. The angular sum of the bends between pull points and/or pull boxes to not exceed 180 degrees.
5. Minimum Inside Bend Radius for Communications Conduit Bends, Sweeps, Boxes and Fittings:
 - a. Underground or Underslab 4-inch Conduit: 60-inches.
 - b. Other Conduit Runs:
 - 1) One-inch conduit, 11-inches
 - 2) Two-inch conduit, 21-inches
 - 3) Three-inch conduit, 36-inches
 - 4) Four-inch conduit, 48-inches
 - 5) Other sizes, 10 times the inside diameter of the conduit.

6. Do not install boxes, bends, elbows, tees, conduit bodies and other conduit fittings, which do not provide for the minimum inside cable bend radius specified in paragraph E above.
 - a. Conduit Bodies: In-line straight-through Type C conduit fittings can be used as pull boxes for conduit up to a maximum of 2-inches ID. Other conduit fittings, which include direction changes such as E, L, LB, LR, LL, LRT, TA, TB and X, are not allowed.
 - b. Refer design or installation conflicts with these requirements to the Architect.
- G. Aboveground Conduit Installation:
 1. Support conduit installed in aboveground interior and exterior locations at a maximum of 7-feet on center.
 2. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps.
 3. Securely attach aboveground conduit under the provisions of this Section.
 4. Only conduit servicing elevator equipment can be installed through elevator shafts or equipment rooms. These conduits may only enter the room and go directly to the equipment being supplied.
 5. Keep power wiring independent of communication system wiring.
 6. Arrange conduit to maintain headroom and present neat appearance.
 7. Do not install conduits on surface of building exterior, across roof, on top of parapet walls, or across floors, unless otherwise noted on drawings.
 8. Exposed conduits are permitted only in the following areas:
 - a. Mechanical rooms, electrical rooms or spaces where walls, ceilings and floors will not be covered with finished material.
 - b. Existing walls that are concrete or block construction.
 - c. Where specifically noted on drawings.
 - d. Route exposed conduit parallel and perpendicular to walls, tight to finished surfaces and neatly offset into boxes.
 9. Do not install conduits or other electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block area passage's intended usage.
 10. Keep conduits a minimum of 12-inches away from steam or hot water radiant heating lines (at or above 104 degrees F) or 3-inches away from waste or water lines.
 11. Run exposed and concealed conduits parallel or perpendicular to walls, structural members, or intersections of vertical planes to provide a neat appearance. Follow surface contours as much as possible.
 12. No section of conduit located within buildings to exceed 100-feet in length between pull points and/or pull boxes.
 13. Expansion/Deflection Joints:
 - a. Where indicated on the Drawings, provide specific purpose expansion/deflection fittings for conduit crossing building expansion/deflection joints in structures or concrete slabs. Expansion fittings to have copper bonding jumper.
 - b. For PVC conduit, provide expansion/deflection joints for 25 degrees F maximum temperature variation. Install in accordance with manufacturer's written instructions.
 - c. For rigid steel conduit located in exterior areas, provide expansion/deflection joints for maximum site temperature variation, installed in accordance with manufacturer's written instructions.
 14. Provide each conduit passing from a nonhazardous or noncorrosive area to a hazardous area and each conduit entering an enclosure within a hazardous area with a sealing fitting in accordance with NEC Article 500. The sealing fitting is to be UL listed and to be filled with approved sealing compound of the same manufacture.
 15. Hubs, Bushings and Insulating Sleeves:
 - a. Interior Box and Cabinet Connections: Install insulating throat connectors wherever conduit terminates in boxes or cabinets. In addition, install bonding type locknuts at metallic conduit terminations.
 - b. Wet and Hazardous Box and Cabinet Connections: Use watertight threaded conduit sealing hubs with insulated throat and bonding type locknuts for fastening rigid steel conduit to cast or sheet metal pull boxes.

- c. Exposed Conduit Terminations: Cap exposed steel communication conduit ends with bushings or smooth collars to protect cable sheath.
16. Flexible Conduit:
- a. Make no bends in flexible conduit that exceed allowable bending radius of the cable to be installed or that significantly restricts the conduit's flexibility.
 - b. A flexible conduit section to be long enough to allow the item to which it is connected to be withdrawn or moved off its base.
 - c. For final connection to telecommunications outlets or equipment, where flexible connection is required to minimize vibration or where required to facilitate removal or adjustment of equipment, provide 12-foot minimum lengths of flexible conduit or as indicated on the Drawings.

H. Pulltape and Duct Plugs:

- 1. Following conduit installation, install pulltape (muletape) with preprinted foot markers in each empty conduit containing a bend or over 10-feet in length, except sleeves, nipples and runs with openings in cleanroom areas. Tie the pulltapes securely at each end.
- 2. Immediately after pulltape installation, install removable manufactured plugs in empty conduit and wireway openings. For underground conduit openings, use screwtight, removable, watertight and dust-tight duct plugs.
- 3. Verify lengths at the time of installation and provide as-built documentation.

3.4 TELECOMMUNICATIONS OUTLET BOXES

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's written instructions and recommendations.
- C. Provide 4-inch by 4-inch by 2-1/8-inch deep outlet boxes for mounting telecommunications outlets with single-gang or double-gang plaster rings as required, or as indicated on the Drawings.
- D. Do not install outlet boxes back to back in walls. Provide minimum 6-inch separation, except provide minimum 24-inch separation in acoustic-rated walls.
- E. Locate outlet boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for outlet boxes. Use boxes with sufficient depth to permit conduit hubs to be located in masonry void spaces.
- F. Provide knockout closures for unused openings.
- G. Support telecommunications outlet boxes independently of conduit.
- H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional outlet boxes.
- I. Install outlet boxes in walls without damaging wall insulation.
- J. Coordinate mounting heights and locations of outlet boxes mounted above counters, benches and backsplashes.
- K. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlet boxes in hollow stud wall.
- L. Provide cast outlet boxes in exterior and wet locations.

3.5 PULL BOXES

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's written instructions and recommendations.

- C. In-Ground: Size and install per manufacturer's recommendations.
- D. Aboveground: Size and install per manufacturer's recommendations.

END OF SECTION

**SECTION 275320
CABLE TELEVISION DISTRIBUTION SYSTEM**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Line Extenders
 - 2. Cables
 - 3. Connectors
 - 4. Splitters
 - 5. Taps
 - 6. Wall Plates

1.2 RELATED SECTIONS

- A. Contents of Division 27, Communications and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Shop Drawings:
 - a. Submit block and riser diagrams identifying system components and interconnection requirements. Include manufacturer's product and part numbers.
 - b. Submit detailed interconnection diagrams for field terminated connections.
 - c. Submit layout drawings showing location of installed devices and cable pathways.
 - 2. Assurance/Control Submittals:
 - a. Test Reports: Provide an outline of tests to be performed before, during and after installation. Include, as a minimum, equipment functionality, cable continuity, cable shorts and picture quality.
 - b. Manufacturer's Instructions: Provide copies of manufacturer's product specification sheets, Record Drawings, operations manuals and maintenance manuals to Owner upon completion of work.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Acceptable Installers: Provide evidence of having been actively engaged in the business of installing and maintaining broadband/television cabling for at least 5 years.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.7 SYSTEM DESCRIPTION

- A. Furnish and install wiring, CATV interface equipment, taps, etc. as shown on Drawings and necessary for complete and operational system.
- B. Performance Requirements:
 - 1. Provide the ability to receive available CATV channels as provided by the local CATV franchise via standard cable-ready television sets (Owner-supplied) and/or set-top converters.
 - 2. Comply with FCC regulations and conform to ANSI/IEEE 802.7 standard for broadband cable systems.
 - 3. Provide equipment capable of operating over the frequency range from 0 to 850 MHz at a minimum.
 - 4. Provide system that allows users to tune to designated channels 2 through 71 on cable-ready television sets (supplied by Owner) to view programs and other broadcast information as provided by the local cable television franchise.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Line Extenders:
 - 1. Blonder Tongue
 - 2. Magnavox
 - 3. Scientific Atlanta
 - 4. Or approved equivalent.
- B. Cables:
 - 1. CommScope
 - 2. Toner
 - 3. Or approved equivalent.
- C. Connectors:
 - 1. Gilbert
 - 2. LRC
 - 3. Blonder Tongue
 - 4. Or approved equivalent.
- D. Splitters:
 - 1. Blonder Tongue
 - 2. Toner
 - 3. Or approved equivalent.
- E. Taps:
 - 1. Blonder Tongue
 - 2. Toner
 - 3. Or approved equivalent.
- F. Wall Plates:
 - 1. Blonder Tongue
 - 2. Toner
 - 3. Or approved equivalent.

2.2 LINE EXTENDERS

- A. Low-split bi-directional amplifier similar to Blonder Tongue. Frequency range 53 to 870 MHz.

2.3 CABLES

- A. Distribution: 1/2-inch, riser or plenum rated as required.
- B. Drop: Riser or plenum rated Series 6.

2.4 CONNECTORS

- A. Pin-type for 0.5-inch cable, F-type for drop cable.

2.5 SPLITTERS

- A. Rated for operation to 1 GHz.

2.6 TAPS

- A. Multiport taps with interchangeable faceplates to adjust isolation level. Rated for operation to 1 GHz.

2.7 WALL PLATES

- A. Provide F-type barrel connectors for insertion in faceplates provided by telephone/data supplier where faceplates are shared with telephone/data drops and similar faceplates with F-type barrel connectors at remaining locations, as shown on the Drawings. Coordinate color and finish with Architect.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of system with the local CATV supplier.
- B. Location: Install line extender and associated passives on wall brackets at the location of telephone/CATV terminal board. Verify the space requirements and exact location with Owner.
- C. Install taps and outlets at locations designated on Drawings. Coordinate exact placement with Owner. Ensure taps are accessible to the Owner without special tools or requirements.
- D. Test complete functional operation of system. Repair and/or replace any part of system that fails to perform properly or meet the specifications at no cost to Owner.
- E. Document cable runs and wire terminations. Label cable terminations per ANSI/EIA/TIA 606 and provide documentation to Owner as described under Submittals.
- F. Field Quality Control:
 - 1. Site Tests: Provide Owner with detailed test reports as outlined through submittal process.
 - 2. Inspection: Provide access to Owner for inspection of installation quality at any time during or upon completion of system installation.
- G. Adjusting/Cleaning: Provide any adjustments or cleaning necessary to system upon completion of construction.
- H. Demonstration and Training: Demonstrate complete operation of system in presence of Owner at a time selected by Owner for final acceptance of system and provide training for efficient operation by Owner's personnel.

3.2 LINE EXTENDERS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.3 CABLES

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.4 CONNECTORS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.5 SPLITTERS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.6 TAPS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.7 WALL PLATES

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

END OF SECTION

SECTION 280001 ELECTRONIC SAFETY BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in 28 00 01, Electronic Safety Basic Requirements applies to Division 28, Electronic Safety work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of electronic safety systems for proposed project.
- B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. Definitions:
 - 1. Provide: To furnish and install, complete and ready for intended use.
 - 2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
 - 3. Install: Includes unloading, unpacking, assembling, erecting, installing, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
 - 4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent," substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
 - 5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities having jurisdiction, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.2 RELATED SECTIONS:

- A. Contents of Section apply to Division 28, Electronic Safety Contract Documents.
- B. Related Work:
 - 1. Additional conditions apply to this Division including, but not limited to:
 - a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - b. Drawings
 - c. Addenda
 - d. Owner/Architect Agreement
 - e. Owner/Contractor Agreement
 - f. Codes, Standards, Public Ordinances and Permits
- C. Contents of Division 26, Electrical apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 28, Electronic Safety Sections and those listed in this Section.
- B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Document, of/from:
 - 1. State of California:
 - a. CBC California Building Code

- b. CEC California Electrical Code
- c. CEC T24 California Energy Code Title 24
- d. CFC California Fire Code
- e. CMC California Mechanical Code
- f. CPC California Plumbing Code
- g. CSFM California State Fire Marshal
- h. DSA Division of State Architect Regulations and Requirements
- i. OSHPD Office of Statewide Health Planning & Development

C. Reference standards and guidelines include but are not limited to the latest adopted editions from:

- 1. ABA Architectural Barriers Act
- 2. ADA Americans with Disabilities Act
- 3. ANSI American National Standards Institute
- 4. ASCE American Society of Civil Engineers
- 5. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning
- 6. ASHRAE Guideline 0, the Commissioning Process
- 7. ASME American Society of Mechanical Engineers
- 8. ASTM ASTM International
- 9. CFR Code of Federal Regulations
- 10. CSA CSA International
- 11. EPA Environmental Protection Agency
- 12. ETL Electrical Testing Laboratories
- 13. FM FM Global
- 14. ISO International Organization for Standardization
- 15. NEC National Electric Code
- 16. NEMA National Electrical Manufacturers Association
- 17. NFPA National Fire Protection Association
- 18. OSHA Occupational Safety and Health Administration
- 19. SMACNA Sheet Metal and Air Conditioning Contractors' National Association
- 20. UL Underwriters Laboratories Inc.
- 21. USDA United States Department of Agriculture

D. See Division 28, Electronic Safety individual Sections for additional references.

E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract.

F. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

G. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

1.4 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures.

B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:

- 1. "No Exceptions Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for

conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.

2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
3. Product Data: Provide manufacturer's descriptive literature for products specified in Division 28, Electronic Safety Sections.
4. Identify/mark each submittal in detail. Note what difference, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the specifications and drawings.
 - a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
 - b. Include technical data, installation instructions and dimensioned drawings for products, equipment and devices installed, furnished or provided. Reference individual Division 28, Electronic Safety specification Sections for specific items required in product data submittal outside of these requirements.
 - c. See Division 28, Electronic Safety individual Sections for additional submittal requirements outside of these requirements.
5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
6. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
7. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 28, Electronic Safety Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical and Division 28, Electronic Safety submittals.
8. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
9. Substitutions and Variation from Basis of Design:
 - a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
 - b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor are required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals." For any product marked "or approved equivalent," a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

- c. Where manufacturer equipment or model numbers are indicated with no exceptions, substitutions will be rejected.
10. Shop Drawings:
- a. Provide coordinated shop drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 28, Electronic Safety specification Sections for additional requirements for shop drawings outside of these requirements.
 - b. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
11. Samples: Provide samples when requested by individual Sections.
12. Resubmission Requirements:
- a. Make any corrections or change in submittals when required by Architect/Engineer review comments. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
 - b. Resubmit for review until review indicates no exceptions taken or "make corrections noted."
 - c. When submitting drawings for Engineers re-review, clearly indicate changes on drawings and "cloud" any revisions. Submit a list describing each change.
13. Operation and Maintenance Manuals, Owners Instructions:
- a. Reference individual Division 28, Electronic Safety Specification Sections for additional requirements for operations and maintenance manuals.
 - b. Submit, at one time, one bound copy and electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
 - 1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
 - 2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes and quantities relevant to each piece of equipment.
 - 3) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub-assemblies.
 - 4) Include Warranty per Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Sections.
 - 5) Include product certificates of warranties and guarantees.
 - 6) Include copy of start-up and test reports specific to each piece of equipment.
 - 7) Include commissioning reports.
 - 8) Engineer will return incomplete documentation without review.
 - 9) Engineer will provide one set of review comments in Submittal Review format. Arrange for additional reviews; Bear costs for additional reviews at Engineer's hourly rates.
 - c. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 28 00 01, Electronic Safety Basic Requirements Article titled "Demonstration."
 - d. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.
14. Record Drawings:
- a. Maintain at site at least one set of drawings for recording "as-constructed" conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements and location of concealed items. Include items changed by addenda, field orders, supplemental instructions, and constructed conditions.

- b. Record Drawings are to include equipment locations, calculations, and schedules that accurately reflect "as constructed or installed" for project.
- c. At completion of project, input changes to original project on CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
- d. See Division 28, Electronic Safety individual Sections for additional items to include in Record Drawings.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials to conform to all local, State, Federal and other applicable laws and regulations.
- B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (e.g. cable tray, panels, etc.) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.
- C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- E. UL and CSA Compliance: Provide products which are UL listed.

1.6 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.
- B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.7 COORDINATION DOCUMENTS

- A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including ceiling suspension and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
- B. Advise Architect in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
- C. Verify in field exact size, location, and clearances of existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.
- D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide like items from one manufacturer, including but not limited to panels, devices and equipment unless otherwise specified in individual Division 28, Electronic Safety Sections.

2.2 MATERIALS

- A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL or FM approved or have adequate approval or be acceptable by state, county, and city authorities.
- B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
- C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- D. Hazardous Materials:
 - 1. Comply with local, State of California, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
 - 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 28, Electronic Safety Sections. In absence of specific requirements, comply with the following:
 - 1. Provide flush mounting access panels for systems and individual components, service of electronic safety systems equipment and junction boxes requiring maintenance, inspection or servicing. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
 - a. Ceiling access panels to be minimum of 24-inch by 24-inch required and approved size.
 - b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
 - c. Provide screwdriver operated catch.
 - d. Manufacturers and Model:
 - 1) Drywall: Karp KDW.
 - 2) Plaster: Karp DSC-214PL.
 - 3) Masonry: Karp DSC-214M.
 - 4) 2 hour rated: Karp KPF-350FR.
 - 5) Manufacturers: Karp, Milco, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.
- B. Install equipment having components requiring access (i.e., devices, equipment, electrical boxes, panels, etc.) so that they may be serviced, reset, replaced or recalibrated by service people with

normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.

- C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.
- D. Earthwork:
 - 1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
 - a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork divisions. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
 - b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
 - c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.
- E. Firestopping:
 - 1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
 - a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around conduit, raceway and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- F. Plenums:
 - 1. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28 Electronic Safety Sections.
- B. Equipment Importance Factor: 1.5.
- C. Confirm Building Risk Category and Seismic Design Category with Architect.
- D. Earthquake resistant designs for Electronic Safety systems (Division 28) equipment and distribution, i.e. equipment, etc. conform to regulations of AHJ.
- E. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by AHJ.
- F. Equipment: Provide means to prohibit excessive motion of equipment during earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.

- B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
 - 1. Underground conduit and wire installation prior to backfilling.
 - 2. Prior to covering walls when electronic safety systems installation is started.
 - 3. Prior to ceiling cover/installation.
 - 4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
- C. Final Punch: Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.4 CONTINUITY OF SERVICE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements in Division 01, General Requirements, comply with individual Division 28, Electronic Safety Sections and the following:
 - 1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
 - 2. Prior to changing over to new system, verify that every item is thoroughly prepared. Install new wiring to point of connection.
 - 3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 - 4. Organize work to minimize duration of power interruption.

3.5 CUTTING AND PATCHING

- A. Confirm Cutting and Patching Requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
 - 1. Proposed floor cutting/core drilling/sleeve locations to be approved by project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
 - 2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
 - 3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
 - 4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, repair, refinish and leave in condition matching existing prior to commencement of work.
 - 5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

- A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

3.7 DELIVERY, STORAGE AND HANDLING

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with the individual Division 28, Electronic Safety Sections and the following:
 - 1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust.
 - 2. Protect equipment and pipe to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
 - 3. Protect devices, panels and similar items until in service.
 - 4. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.

3.8 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.
- B. Upon completion of work and adjustment of equipment, test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Staff as specified in Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.
- C. Manufacturer's Field Services: Furnish services of a qualified factory certified instructor at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.9 CLEANING

- A. Confirm cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28 Sections.
- B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

- A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.
- B. Install equipment in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to building structure. Maintain manufacturer's recommended clearances.
- C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- D. Provide miscellaneous supports required for installation of equipment, conduit and wiring.

3.11 PAINTING

- A. Confirm Painting requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces, i.e. hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
 2. In electrical and mechanical room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
 3. See individual equipment Specifications for other painting.
 4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
 5. Conduit: Clean, primer coat and paint interior conduit exposed in finished areas with two coats paint suitable for metallic surfaces. Color selected by Architect.

3.12 ACCESS PANELS

- A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
1. Coordinate locations/sizes of access panels with Architect prior to work.

3.13 DEMOLITION

- A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In the absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
1. Scope:
 - a. It is the intent of these documents to provide necessary information and adjustments to electronic safety system required to meet code, and accommodate installation of new work.
 - b. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
 - c. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas. Owner will cooperate to best of their ability to assist in coordinated schedule, but will remain final authority as to time of work permitted.
 2. Examination:
 - a. Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to locate and preserve utilities. Replace damaged items with new material to match existing.
 - b. Verify that abandoned wiring and equipment serve only abandoned facilities.
 - c. Demolition drawings are based on casual field observation and existing record documents.
 - 1) Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish work.
 - 2) Verify location and number of electronic safety system devices, panels, etc. in field.
 - d. Report discrepancies to Architect before disturbing existing installation.
 3. Promptly notify Owner if systems are found which are not shown on Drawings.
 4. Execution:
 - a. Remove existing electronic safety equipment, devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless shown as retained or relocated on Drawings.
 - b. Provide temporary wiring and connections to maintain electrical continuity of existing systems during construction. Remove or relocate electrical boxes, conduit, wiring and

- equipment as encountered in removed or remodeled areas in existing construction affected by this work.
- c. Remove and restore wiring which serves usable existing outlets clear of construction or demolition.
 - d. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, provide new conduit and wire to bypass abandoned outlets.
 - e. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and wire to reroute clear of construction or demolition and maintain service to existing load.
 - f. Extend circuiting and devices in existing walls to be furred out.
 - g. Remove abandoned wiring to source of supply.
 - h. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
 - i. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
 - j. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
 - k. Remove abandoned wiring to leave site clean.
 - l. If existing electrical equipment contains PCBs (Polychlorinated Biphenyl), replace with new non-PCB equipment. Dispose of material containing PCBs as required by federal and local regulations.
 - m. Repair adjacent construction and finishes damaged during demolition work.
 - n. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
5. Existing Fire Alarm System: Maintain existing system in service. Disable system only to make switchovers and connections.
- a. Notify and coordinate with Owner before partially or completely disabling system.
 - b. Notify and coordinate with local fire service.
 - c. Make notifications at least 5 working days in advance.
 - d. Make temporary connections to maintain service in all areas adjacent to work area.

3.14 ACCEPTANCE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
 1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
 - a. Cleaning
 - b. Operation and Maintenance Manuals
 - c. Training of Operating Personnel
 - d. Record Drawings
 - e. Warranty and Guaranty Certificates
 - f. Start-up/test Documents and Commissioning Reports

3.15 FIELD QUALITY CONTROL

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
 1. Tests:
 - a. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in Closeout Documents.
 - b. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 LETTER OF CONFORMANCE

- A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement in letter that electronic safety systems were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in operating and maintenance manuals.

END OF SECTION

SECTION 283100 FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Fire Alarm Initiating and Control Devices
 - 2. Fire Alarm Notification Appliances
 - 3. Miscellaneous
- B. In addition, provide design for the following as required in these Contract Documents:
 - 1. Fire Alarm System
- C. In addition, remove existing fire alarm system in tenant improvement areas.
- D. Scope:
 - 1. Provide modification and extension of the existing fire alarm system to accommodate tenant improvement.
 - 2. These are Contractor designed systems. Contact AHJ prior to bid to verify systems' requirements. Design systems in compliance with code as interpreted by the AHJ.

1.2 RELATED SECTIONS

- A. Contents of Division 28, Electronic Safety and Division 01, General Requirements apply to this Section.
- B. Division 26, Electrical requirements apply to this section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Division 28, Electronic Safety and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. NFPA 72, National Fire Alarm and Signaling Code, adopted edition.
 - 2. NFPA 70, National Electrical Code, adopted edition.

1.4 SUBMITTALS

- A. Submittals as required by Division 28, Electronic Safety and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Shop drawings to include the following:
 - a. Identification of system designer and evidence of qualification or certification of designer as required by AHJ.
 - b. System designer NICET certification number or Engineer's signature and seal.
 - c. Floor plans indicating walls, doors, partitions, room descriptions, device/component locations.
 - d. Ceiling height and ceiling construction details.
 - e. A symbol legend with device catalog number, description, back box size and mounting requirements.
 - f. Detailed riser diagram.
 - g. Device label adjacent to each device symbol. Notification appliance circuit and number adjacent to each notification appliance symbol.

- h. Point to point wiring indicating the quantity and gauge of the conductors and size of conduit/raceway used.
 - i. Wiring connection diagrams for control equipment, annunciators, power supplies, chargers, initiating devices, notification appliances, components being connected to the system and interfaces to associated equipment.
 - j. Battery calculations for each battery backed fire alarm control unit.
 - k. Voltage drop calculations for each notification appliance circuit, indicating individual appliance current draw, conductor run length and size.
 - l. Complete sequence of operation.
2. Prior to final acceptance, submit a letter confirming that inspections have been completed and system is installed and functioning in accordance with Specifications. Include manufacturer representative's certification of installation and letter of warranty.
 3. Operation and Maintenance Manuals. Provide manuals containing the following:
 - a. Catalog Cut Sheets
 - b. System Components, Initiating Devices and Notification Appliances' Installation Sheets
 - c. Manufacturer's Installation, Operation and Maintenance Manual
 - d. Program Data File Printout
 - e. Program Data File on Electronic Storage Media
 - f. Record Drawings
 - g. Record Drawings on Electronic Storage Media
 - h. One year warranty agreement including parts and labor. Warranty period begins upon date of completion.
 - i. Record of Completion
 - j. Test Reports
 - k. Instruction Chart

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Division 28, Electronic Safety and Division 01, General Requirements.
- B. In addition, meet the following:
 1. Contact AHJ prior to bid and provide required fire alarm and detection devices and components as required by adopted codes as interpreted by AHJ.
 2. City of San Mateo, California requirements, ordinances and amendments.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Division 28, Electronic Safety and Division 01, General Requirements.
- B. Contractor shall include, as part of the one-year warranty, a test and inspection of the entire fire alarm system at least one month prior to expiration of the one-year construction warranty. Contractor shall provide a written report of any deficiencies and repair any of the deficiencies. The test shall conform to the certification per NFPA 72 adopted edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Furnish fire alarm control equipment specified in this Section by one manufacturer:
 1. To match the existing
 2. Or approved equivalent.
- B. Notification Appliance Circuit Panels:
 1. Basis of Design: Same manufacturer as the existing fire alarm control equipment.

2. Or approved equivalent.
- C. Initiating and Control Devices:
 1. Basis of Design: Same manufacturer as the existing fire alarm control equipment.
- D. Notification Appliances: Notification appliances must be compatible with control equipment and notification appliance circuit panels.
 1. Basis of Design: Same manufacturer as the existing control equipment.
 2. Or approved equivalent.
- E. Substitutions:
 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
 2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with contract documents.
- F. Equipment to be supplied by a certified manufacturer representative.

2.2 COMPONENTS

- A. General: Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.
- B. Fire Alarm Control Unit (Existing):
 1. Modify existing zone configuration to accommodate remodel project.
 2. Power Supply (If required):
 - a. Provide power supply(s), adequate to serve control panel modules, remote annunciators, devices, notification appliances, and other connected devices.
 3. Power Requirements:
 - a. Loss of normal and emergency power automatically causes system to transfer to battery power. Indicate battery power operation by yellow lamp and audible annunciation at control panel and remote annunciator panels. Upon return of 120VAC power, unit recharges batteries to full capacity and maintains battery on float charge. Provide trickle charge adequate capacity to maintain battery fully charged with automatic rate charge.
 - b. Provide batteries in locking cabinet manufactured for purpose.
 4. Auxiliary Relays (If required):
 - a. Provide sufficient SPDT auxiliary relay contacts for each function in this portion of the Specifications and for equipment interconnections required under electrical and mechanical specifications.
 5. Auxiliary Switches (If required):
 - a. Provide auxiliary equipment control switches with labeled status indicating lights for each switch.
- C. Fire Alarm Initiating and Control Devices (To match the existing U.O.N):
 1. Manual Pull Stations:
 - a. Semi-flush single action, red finish, nongrasping operation; maximum pull strength as allowed per ADA criteria.
 - b. Stations do not allow closure without keyed reset.
 2. Fixed Temperature Heat Detectors:
 - a. Rated 135 degrees F or 190 degrees F as required by space use.
 - b. Provide off white low profile detectors.
 - c. Where new detectors are required, provide the latest devices available to the extent compatible with the existing system.
 3. Rate-of-Rise and Fixed Temperature Heat Detectors:
 - a. Responding to 15 degrees F temperature rise per minute and to 135 degrees F fixed temperature as required by space use.

- b. Provide off white low profile detectors.
 - c. Where new detectors are required, provide the latest devices available to the extent compatible with the existing system.
4. Photoelectric Detectors:
- a. LED source, multiple cell, 360 degree smoke entry, visual latching operation indicator, insect screen, functional test switch, two-wire operation and vandal resistant locking feature.
 - b. Where new detectors are required, provide the latest devices available to the extent compatible with the existing system.
5. Duct-Mounted Smoke Detectors:
- a. Photoelectric type , auxiliary relay contacts rated at 5 amps each at 120VAC. Duct sampling tubes extending width of duct, visual indication of detector actuation, direct housing mount. Detector powered from control panel or alternate supply, power on indicator light. Detector rated for air velocity, humidity, and temperature of duct and environment where installed. Provide with a remote LED/test switch.
 - b. Where new detectors are required, provide the latest devices available to the extent compatible with the existing system.
- D. Fire Alarm Notification Appliances (To match the existing):
1. Combination Horn/Strobe:
 - a. Multi-candela, flush wall and ceiling mount , white finish, insect-proof.
 - b. Provide horn/strobes that meet the latest requirements of NFPA 72, ANSI 117.1 and UL 1971. Candela rating as required by NFPA 72.
 2. Strobe:
 - a. Multi-candela, flush wall and ceiling mount , white finish, insect-proof.
 - b. Provide strobes that meet the latest requirements of NFPA 72, ANSI 117.1 and UL 1971. Candela rating as required by NFPA 72.
 3. Horn:
 - a. Flush wall and ceiling mount , white finish, insect-proof.
 - b. Provide horns that meet the latest requirements of NFPA 72.
- E. Miscellaneous:
1. Weatherproof/Surface Backboxes:
 - a. Provide manufacturer's weatherproof backbox listed for use in areas where the device or appliance is subject to humidity in excess of listed rating. Provide manufacturer surface backboxes where devices cannot be installed recessed.
 2. Protective Guard: Steel wire guard .
 3. Circuit Conductors:
 - a. Copper or optical fiber; color code and label. Type FPL, FPLR and FPLP as required by NEC. Minimum signaling line circuit and initiating device circuit wire size: AWG18. Minimum notification appliance circuit wire size: AWG14, or as approved by Engineer.
 - b. Fiber optic cable as required by manufacturer.
 4. Surge Protection:
 - a. In accordance with IEEE C62.41 B3 combination waveform and NFPA 70; except for optical fiber conductors.
 - b. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 5. Batteries (To match the existing):
 - a. Sealed lead acid type.
 - b. Provide additional cabinet, if required due to space limitations in control panels.
 6. Locks and Keys (If required):
 - a. Deliver keys to Owner.
 - b. Provide same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type.
 7. Document Storage Cabinet:

- a. Suitable for as-built drawings, operation and maintenance manual, system data file disk, and tools.
- b. Constructed from steel with baked enamel finish, size adequate for full size drawings, operation and maintenance manual, spare parts and tools.

PART 3 - EXECUTION

3.1 DESIGN CRITERIA

- A. These are Contractor designed systems. Contact AHJ prior to bid to verify systems' requirements. Design systems in compliance with code as interpreted by the AHJ.
- B. Provide design of the following systems as required by code:
 - 1. Fire alarm system (modification to the existing).
- C. System Operation:
 - 1. Alarm Sequence of Operation: Match Existing.
 - 2. Supervisory Sequence of Operation: Match Existing.
 - 3. Trouble Sequence of Operation: Match Existing.
- D. Circuits:
 - 1. Initiating Device Circuits (IDC): Class B.
 - 2. Notification Appliance Circuits (NAC): Class B.
- E. Spare Capacity:
 - 1. Notification Appliance Circuits: Minimum 25 percent spare current capacity. Utilize UL maximum current draw values for notification appliances. Maximum 10 percent voltage drop.
- F. Power Sources:
 - 1. Primary: Dedicated branch circuits of facility power distribution system.
 - 2. Secondary: Storage batteries.
 - 3. Capacity: Sufficient to operate fire alarm system under normal supervisory condition for 24 hours and operate alarm signals for 5 minutes at end of standby period.

3.2 INSTALLATION

- A. Obtain approval of system design from AHJ prior to installation. Do not begin installation without approval from AHJ and submittal review comments from Engineer.
- B. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the Contract Documents.
- C. In accordance with manufacturer's instructions, provide wiring, conduit and outlet boxes required for the erection of a complete system as described in these specifications, as shown on Drawings, and as required by AHJ.
- D. Provide wiring to meet the requirements of national, state and local electrical codes. Provide color coded wiring as recommended and specified by the fire alarm and detection system manufacturer. Provide Type FPLR cable when in a riser application or FPLP cable when installed in plenums.
- E. Conceal wiring, conduit, boxes, and supports where installed in finished areas.
- F. Provide raceway system for cabling concealed in walls and hard ceilings and in locations where cabling is exposed. Where exposed, provide surface raceway in finished areas and surface mounted EMT in non-finished areas.
- G. Provide cabling and conduits system suitable for wet locations for below grade systems.

- H. At junction boxes and termination points, provide identification tags on wires and cables.
- I. Route wiring to avoid blocking access to equipment requiring service, access, or adjustment.
- J. Provide machine printed zone labels on devices. Labels to be visible from the floor without magnification.
- K. Obtain Owner's approval of locations of devices, before installation.
- L. Provide control panel and remote power supplies with 120VAC dedicated circuit per NFPA requirements.
- M. Do not install cabinets or equipment below the battery cabinet. Do not locate battery and charging system cabinets in ceiling space.
- N. Provide wire guards or protective covers where device is subject to abuse and where required by AHJ.
- O. Provide document storage cabinet adjacent to fire alarm control panel.
- P. Room Name Labeling: Control unit schedules, programming, and labeling for electrical equipment, to use the room names and room numbers that the Owner adopts at the date of substantial completion of construction. This work is to be done at no added cost to the Owner.

3.3 FIRE SAFETY SYSTEMS INTERFACES

- A. Fire Safety Functions: Provide power and control conduit, wiring, boxes and terminations to power devices and interface to the existing fire alarm system.
 - 1. Doors:
 - a. Provide smoke detectors and control relays to release magnetic hold open devices and roll-down fire doors and door locks. Verify requirements and quantities prior to bidding.
 - b. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door.
 - c. Electronic Locks or Electromagnetic Door Locks on Egress Doors: Unlock smoke zone egress doors upon activation of any alarm initiating device or suppression system in smoke zone.
 - d. Overhead Coiling Fire Doors: Release upon activation of smoke detectors on either side of door.
 - 2. HVAC Systems:
 - a. Fire/Smoke Dampers and Smoke Dampers:
 - 1) Provide required smoke detectors, relays, wiring, and the like.
 - 2) Connect control and power wiring to dampers per manufacturer's instructions.
 - 3) Verify quantities, location and requirements of dampers with Division 23, HVAC Drawings and Specifications, and mechanical system installer.
 - 4) Provide control wiring, transformers and power connections for an operable damper and detection system.
 - b. Air Moving Systems:
 - 1) Provide duct-mounted smoke detectors on air systems with air flow rates exceeding 2000 CFM. Coordinate with Division 23, HVAC.
 - 2) Install duct-mounted smoke detector(s) on supply side of air system.
 - 3) Provide control wiring from relay contacts to air handling equipment controller. Connect to controller so that when duct-mounted smoke detector is activated, the air handling equipment is shut down.
 - 4) Provide duct-mounted smoke detectors rated for air velocity, temperature, and humidity of duct. Verify quantities, locations, and requirements with Division 23, HVAC Drawings and mechanical system installer.
 - 5) Where duct-mounted smoke detectors are mounted in inaccessible building void spaces provide access hatch. Provide access hatch with fire rating equivalent to rating of wall, ceiling, or shaft being penetrated.

3.4 EXISTING COMPONENTS

- A. On-Premises Supervising Station: Include, as part of this work, modifications necessary to existing supervising station to accommodate new fire alarm work.

3.5 INSPECTION AND TESTING FOR COMPLETION

- A. System testing and commissioning to be performed by a certified manufacturer representative.
- B. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- C. Document audibility and intelligibility measurements for each space on record drawings.
- D. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- E. Provide tools, software, and supplies required to accomplish inspection and testing.
- F. Prepare for testing by ensuring that work is complete and correct; perform preliminary tests as required to test system.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- H. Notify Owner 7 days prior to beginning completion inspections and tests.
- I. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- J. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 - 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, complete and submit NFPA 72 "Inspection and Testing Form."

3.6 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by AHJ. Notify AHJ in time to schedule demonstration.
 - 5. Repeat demonstration until successful.
- B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.

3. Spare parts, extra materials, and tools shall be delivered to the Owner. Spare parts shall also include one (1) percent of the installed quantity of each notification appliance type, but not less than one of the following:
 - a. Audio and Visual Appliances
 - b. Addressable Devices
4. All aspects of operation have been demonstrated to Owner.
5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
6. Occupancy permit has been granted.

END OF SECTION

SECTION 311001 PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Preserve and protect existing trees, shrubs and other plant materials to remain, including protecting plants on adjoining properties during site preparation work and construction.
- B. Provide tree and shrub pruning and removal.
- C. Layout and review of utility and irrigation trenches that occur in the Tree Protection Root Zone

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. Ordinances and Regulations: All local, municipal and state laws, codes and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship or construction of a better quality, higher standard than is required by the above mentioned codes and regulations, the provisions of these Specifications and Drawings shall take precedence. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.
 - 2. International Society of Arboriculture, Guide for Plant Appraisal, latest version.

1.3 DEFINITIONS

- A. Diameter at Breast Height of tree trunk (DBH)
 - 1. Location 54 inches from the ground as measured on the high side of the tree trunk.
- B. Tree Protection Zone (TPZ)
 - 1. Root Area around tree that is 5 times the DBH, or the tree Dripline, whichever is greater.
- C. Structural Root Zone (Radius of Three)
 - 1. The Structural Root Zone is a circular area with the tree trunk at the center and a radius equal to 3 times the diameter of the tree trunk measured at breast height (4.5 feet above ground line). This zone, where most of the structural roots exist, is based upon tree failure research conducted by E.T. Smiley at the Bartlett Tree Research Laboratory. Any structural (buttress) root, which has been severed or is rotten within this zone, can no longer provide adequate support to the tree and must be considered missing.
- D. Dripline
 - 1. The area of the ground directly beneath the vertical projection (shadow) of the trees foliage canopy.

1.4 QUALITY ASSURANCE

- A. Review:
 - 1. Contractor shall review and identify with the Owner's Representative the limits of Work and extent of plant materials to be protected and any to be pruned or removed.
 - 2. At the Owner's discretion, an Arborist may represent the Owner to review the work of the Contractor in regards to plant protection.

- B. Stipulations

1. Plant Protection:

- C. At the Owner's expense, an Arborist may represent the Owner to review the work of the Contractor in regards to plant protection, defining the tree protection zone, and tree protection strategies.
- D. Contractor shall review and identify with the Owner's Representative the limits of Work and extent of plant materials to be protected and any to be pruned or removed.
- E. Protect trees against cutting, breaking, skinning and bruising of bark
- F. Do not change earth surface within drip line of trees except as approved in writing by the Owner.
- G. Do not park vehicles or store materials, supplies and construction equipment within drip line of trees.
- H. Install a temporary 6-foot high chain link fence typically at the "drip line" of the tree(s) except as otherwise directed by the Arborist / Owner's Representative.
- I. Obtain specific instruction from Arborist / Owner's Representative for pruning of trees, shrubs, roots or disturbance of soil within spread of tree branches. The Contractor shall utilize protection measures as outlined by Arborist / Owner's Representative, which may include directional drilling, or hand clearing to expose the roots
- J. Generally cutting of roots two inches or greater shall be avoided. Roots one inch and greater in diameter that must be cut shall be cut cleanly and obliquely with the cut surface facing down.

1.5 PLANT REPLACEMENT

- A. Contractor shall replace cut or severely damaged trees and plants due to the Contractor's work as with in-kind "specimen" trees and plants of equal value at no cost to Owner.
- B. Tree removal permits to be obtained by Contractor.

PART 2 - PRODUCTS

1.6 PROTECTIVE FENCING

- A. PROTECTIVE FENCING: chainlink & plastic vinyl protection fencing
- B. WOOD BRACING FOR TRUNKS & BRANCHES: 2x lumber secured w/ steel straps.

PART 3 - EXECUTION

1.7 EXAMINATION

- A. Examine areas in which work is to be performed. Report in writing to the Owner's Representative all prevailing conditions that will adversely affect the existing plant materials to remain. Do not proceed with work until a solution acceptable to the Owner's Representative has been arrived at.
- B. Install and maintain temporary fencing and other required protective devices and exclude construction activities from tree/shrub zones except as supervised by the Arborist / Owner's Representative.

- C. If access to tree/shrub zones cannot be avoided an intact four inch layer of mulch with minimum 1.25 inch thick, metal strap linked plywood shielding shall be maintained in the tree/shrub zone where heavy equipment will be operated.
- D. Locate and clearly flag trees and vegetation to remain or to be relocated, as diagrammed and noted in the Construction Documents.

1.8 TRENCH LOCATION CONFIRMATION IN ROOT ZONES

- A. Where utility line trenches, including irrigation mainlines and lateral line trenches, occur in Tree Protection Zones, Contractor shall layout exact proposed trench locations and review locations with the Owner's Representative. If in the opinion of the Owner's Representative it is found that, trench locations can be adjusted to avoid cutting root systems 2" and larger without affecting the designed function of lines and systems, the Contractor will not be required to Air Spade or Tunnel in order to install the utilities. Adjustment of trench locations to avoid cutting root systems shall be at no additional cost to the Owner.

1.9 TREE REMOVAL

- A. Field Verification: Before removing non-designated trees, shrubs, stumps, bushes, vines, rubbish, undergrowth and deadwood as shown on the Drawings and as specified, obtain verification from Owner's Representative.
- B. Backfill and compact areas excavated and open pits and holes resulting from removal operations. Comply with requirements herein and as specified in Earthwork, Section 02300 for backfill materials, compaction and installation methods.
- C. Remove all stumps and roots in their entirety. Tree trunks shall be removed minimum depth of 2 1/2 feet below existing grade or finish grade, whichever is deeper. Stump grinding is an acceptable method of removal of roots and stumps of trees and shrubs; however, the chip contaminated soil shall be replace with approved clean planting soil in planting areas and with approved clean fill soil in all other areas.
- D. Backfill and compact voids excavated and open pits and holes resulting from removal operations. Comply with Earthwork Specification for backfill materials, compaction and installation methods. Unless required otherwise, in planting areas backfill holes with clean approved planting soil compacted to 90% relative compaction to a minus 12 inches below finish grade and 85% relative compaction for the top 12 inches, except as required elsewhere to a greater degree by Civil or Structural Engineer. In non-planting areas backfill holes with approved fill soil compacted to 95% relative compaction.

END OF SECTION

SECTION 311100 CLEARING AND GRUBBING

1.1 GENERAL

2.0 SUMMARY

- A. Clearing vegetation, debris, trash and other materials within limits indicated.
- B. Grubbing of vegetation within limits indicated.

1.2 RELATED DOCUMENTS

- A. Caltrans Standard Specifications.
 - 1. Section 16, Clearing and Grubbing.

1.2 PRODUCTS

NOT USED

1.3 EXECUTION

2.0 PREPARATION

- B. Locate and clearly flag vegetation to remain or to be relocated.

2.1 RESTORATION

- C. Repair or replace vegetation indicated to remain that is damaged by construction operations, as directed by the Owner.
- D. Employ a qualified arborist, licensed in jurisdiction where the Project is located, to submit details of proposed repairs and to repair damage to shrubs.

2.2 CLEARING AND GRUBBING

- E. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
- F. Remove trash, debris, logs, concrete, masonry and other waste materials.
- G. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
- H. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18-inches below subgrade.
- I. Use only hand methods for grubbing within drip line of remaining trees.

END OF SECTION

**SECTION 311300
SELECTIVE TREE REMOVAL AND TRIMMING**

1.1 GENERAL

1.1 SUMMARY

- A. Protecting existing trees and vegetation to remain.
- B. Trimming tree limbs and roots.
- C. Removing trees as designated.

1.2 DEFINITIONS

- A. ANSI: American National Standards Institute.
- B. CAL-OSHA: California Occupational Safety and Health Administration.

1.3 QUALITY ASSURANCE

- A. Do not remove or prune trees without first securing a permit from the appropriate agency.
- B. Prune to the standards of the International Society of Arborists and to ANSI 300.

1.2 PRODUCTS

NOT USED

1.3 EXECUTION

3.1 PREPARATION

- C. Locate and clearly flag trees to remain or to be relocated.

3.2 TREE PROTECTION

- A. Erect and maintain temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
- B. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
- C. Do not permit vehicles or equipment within drip line of remaining trees.
- D. Do not excavate within drip line of remaining trees, unless otherwise indicated.
- E. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation edge as possible.
- F. Cover exposed roots with burlap and water regularly.
- G. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
- H. Coat cut faces of roots more than 1-1/2-inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
- I. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

3.3 TREE PRUNING

- A. Prune trees to balance the crown, and eliminate hazards. Perform main work to reduce sail effect through thinning, reducing end weights, shortening long heavy limbs, removing deadwood, weak limbs and sucker growth. Prune limbs back to an appropriate lateral branch.

- B. Make final cuts at the outer edge of the branch collar in accordance with the arborist's recommendations.
- C. Perform pruning work in a safe and proper manner, adhering to CAL-OSHA and ANSI Standards.

3.4 ROOT PRUNING

- A. Do not cut tree roots greater than 3-inch in diameter and less than 12-inches below ground level without approval of the Owner.
- B. Cut tree roots cleanly, as far from the trunk as possible, and not underneath any area where walkways are to be constructed. Root pruning shall be to a depth of 18-inches.
- C. Tree root prune using a Vermeer root-cutting machine. Obtain the Owner's approval before using alternate equipment or techniques.
- D. Complete tree root pruning prior to any excavation adjacent to the tree.
- E. Do not expose tree roots to drying out. Cover root ends with soil or burlap and keep moist until the final backfill is completed.

3.5 TREE REMOVAL

- A. Remove trees designated for removal prior to the construction of new improvements.
- B. Perform tree removal work in a safe and proper manner, adhering to CAL-OSHA and ANSI Standards.
- C. Remove or grind stumps to a minimum of 18-inches below finish subgrade. Remove surface roots to this depth within 24-inches of the tree trunk.

3.6 RESTORATION

- A. Repair or replace trees indicated to remain that are 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 trees.
- C. Replace trees that cannot be repaired and restored to full-growth status, as determined by the Owner.

END OF SECTION

**SECTION 311400
EARTH STRIPPING AND STOCKPILING**

PART 1 GENERAL

1.1 SUMMARY

- A. Stripping of topsoil within limits indicated.

1.2 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2-inches in diameter; and free of weeds, roots, and other deleterious materials.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Remove trash, debris, weeds, roots, organics and other deleterious waste materials.
- D. Stockpile topsoil materials designated to remain on site at a location approved by the Owner at a location away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
- E. Do not stockpile topsoil within drip line of remaining trees.

3.2 DISPOSAL

- A. Remove surplus soil material and unsuitable topsoil, and legally dispose of them off the Owner's property.

END OF SECTION

SECTION 312300 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 312333 – Trenching and Backfilling.

1.3 RELATED SECTIONS

- A. Section 311100 – Clearing and Grubbing
- B. Section 312333 – Trenching
- C. Section 313119 – Vegetation Control
- D. Section 334600 – Subdrainage

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.
 - 4. D 3740, Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - 5. D 4318, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 - 6. E 329, Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
 - 7. E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.
- C. California Administrative Code, Title 24, Part 2 - Basic Building Regulations, Chapter 24, Excavations, Foundations, and Retaining Walls.
- 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. Testing agency shall be certified by DSA.

- 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/Engineered 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 $\frac{3}{4}$ -cubic yards or more in volume that when tested by an independent geotechnical testing agency, 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. The Geotechnical Consultant will determine if a soil material is unsuitable.
- J. Utilities: onsite underground pipes, conduits, ducts and cables.

1.6 SUBMITTALS

- A. Follow submittal procedures outlined in Division 1.
- 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.

1.7 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 Caltrans Standard Specifications, Section 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 48-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 and the Geotechnical Report. The Contractor shall be responsible for the stability of all fills and backfills constructed by his forces and shall replace portions that in the opinion of the Geotechnical Consultant have been displaced or are otherwise unsatisfactory due to the Contractor's operations.
- G. Finish soil grade tolerance at completion of grading:
 1. Building and paved areas: +0.02 feet.
 2. Landscape areas: ± 0.10 feet.
 3. Cut or fill slopes: ± 0.250 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 4 inches in greatest dimension, shall have a liquid limit of less than 40, a plasticity index of less than 15, and shall be free of organic content. In addition, the fill should contain 10 to 25 percent of fines (particles passing the No. 200 sieve).
- 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 wet weather 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 8 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-foot minimum into competent, undisturbed soil or 3-foot minimum into competent, undisturbed rock as directed by the Geotechnical Consultant.
- B. Place subsurface drains in bottom of keyway in conformance with Section 334600 – 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 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 as outlined below or as directed by the Geotechnical Consultant:
 - 1. Exposed subgrade shall be scarified to a depth of at least 8-inches and recompacted to 90 percent compaction.
 - 2. Compact structural fill to 90 percent compaction.
 - 3. Compact the upper 6-inches of subgrade soils beneath pavements, curbs and gutters to 95 percent compaction. Extend compaction 3-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 95 percent compaction.

3.12 DISPOSAL

- A. Lawfully dispose of all unsuitable and excess or surplus material off-site at no cost to the Owner.

END OF SECTION

SECTION 312333 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. See Section 33 46 00 – Subdrainage.
- 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 312300 – Excavation and Fill
- B. Section 334600 – Subdrainage
- C. Section 334000 – Storm Drainage

1.4 RELATED DOCUMENTS

- A. Geotechnical Report.
- B. ASTM:
 - 1. C 33, Specification for Concrete Aggregates.
 - 2. C 150, Specification for Portland Cement.
 - 3. C 260, Specification for Air-Entraining Admixtures for Concrete.
 - 4. C 618, Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
 - 5. D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
 - 6. D 2321, Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
 - 7. D 2487, Classification of Soils for Engineering Purposes.
 - 8. D 3740, Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - 9. E 329, Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
 - 10. E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.
- C. California Administrative Code, Title 24, Part 2 - Basic Building Regulations, Chapter 24, Excavations, Foundations, and Retaining Walls.
- D. Caltrans Standard Specifications:
 - 1. Section 19, Earthwork.
 - 2. Section 26, Aggregate Bases.
 - 3. Section 68, Subsurface Drains.
 - 4. Section 88, Engineering Fabrics.
- E. CAL/OSHA, Title 8.

1.5 DEFINITIONS

- A. AC: Asphalt Concrete.
- B. ASTM: American Society for Testing and Materials.
- 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 $\frac{1}{2}$ 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 Division 1.
- 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.

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 Section 02000, Supplemental General Requirements for Civil Improvements.

PART 2 PRODUCTS

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. Class 2 Aggregate Base: Conform to Section 26 of Caltrans Standard Specifications, ¾-inch maximum.

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.
- B. Class 2 Aggregate Base: Conform to Section 26 of Caltrans Standard Specifications, ¾-inch maximum.

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 88-1.03 of Caltrans Standard Specifications.
 - 2. Mirifi 140N (Mirifi Inc., Charlotte, NC) (Tel. 800-438-1855) or equal.

PART 3 EXECUTION

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 that the upper 36-inches in areas subject to vehicular traffic shall be compacted to at least 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 subsequent backfill material will not be permitted.
- D. Do not use compaction equipment or methods that produce horizontal or vertical earth pressure 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-compact 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.
- B. See Section 017400 – Cleaning and Waste Management for further cleanup requirements.

END OF SECTION

**SECTION 313119
VEGETATION CONTROL**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Application of soil sterilant on subgrades for roadways, driveways, parking areas, walks, paths, trails and any other site improvements called for on the plans.

1.2 RELATED SECTIONS

- A. Section 312300 – Excavation and Fill.

1.3 RELATED DOCUMENTS

- A. CAL/OSHA, Title 8.

1.4 SUBMITTALS

- A. Follow submittal procedures outlined in Section 013300 – Submittal Procedures.

PART 2 PRODUCTS

2.1 SOIL STERILANT

- A. Commercial chemical for weed control, registered by EPA. Provide granular, liquid or wet-able powder form.

PART 3 EXECUTION

3.1 SOIL STERILIZATION

- A. Apply soil sterilant to areas indicated, such as beneath asphalt concrete pavement, brick pavement, concrete pavement and at grade concrete slabs, including sidewalks, curbs and gutters. Also where indicated apply soil sterilant below expansion and control joints and at areas where pipes, ducts or other features penetrate slabs.
- B. Apply soil sterilant uniformly and at the rates recommended by the manufacturer.
- C. Apply soil sterilant to prepared subgrade, or after installation of aggregate base as recommended by the manufacturer.

3.2 DISPOSAL

- A. Lawfully dispose of all unsuitable and excess or surplus material off-site at no cost to the Owner.

END OF SECTION

**SECTION 320513
SOIL FOR BIORETENTION FACILITIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Soil for bioretention facilities.

1.2 SECTION EXCLUDES

- A. Drainage fill material and placement around subdrains. See Section 334600.
- B. Trenching and backfill for utilities such as underground water, sewer, storm drainage, electric, telephone, gas, cable TV, etc.
- C. Import fill.
- D. Structural fill.

1.3 RELATED SECTIONS

- A. Section 312300, Excavation and Fill.
- B. Section 312300, Utility Trenching and Backfilling
- C. Section 334000, Storm Drainage Utilities.
- D. Section 334600, Subdrainage.

1.4 RELATED DOCUMENTS

- A. Geotechnical Report.
- B. ASTM:
 - 1. C 33, Specification for Concrete Aggregates.
 - 2. D 422, Standard Test Method for Particle Size Analysis of Soils
 - 3. D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
 - 4. D2434, Constant head permeability.
 - 5. D 2487, Classification of Soils for Engineering Purposes.
 - 6. D 3740, Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - 7. D 4318, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 - 8. E 329, Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
 - 9. E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.
- C. California Building Code, California Code of Regulations, Title 24, Part 2 - Chapter 33, Site Work, Demolition and Construction.
- D. Caltrans Standard Specification Section
 - 1. Section 19, Earthwork.
- E. US Composting Council, Testing Methods for the Examination of Compost and Composting (TMECC)
 - 1. (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
- F. US EPA, 40 CFR 503 Regulations.
- G. CAL/OSHA, Title 8.

1.5 DEFINITIONS

- A. ASTM: American Society for Testing and Materials.
- B. Bedding: Material from bottom of trench to bottom of pipe.

- C. C:N Ratio: Carbon to Nitrogen Ratio.
- D. Initial Backfill: Material from bottom of pipe to 12-inches above top of pipe.
- E. USCS: United States Composting Council.
- F. STA: Seal of Testing Assurance.
- G. TMECC: Testing Methods for the Examination of Compost and Composting.
- H. 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.
- I. Subsequent Backfill: Material from 12-inches above top of pipe to subgrade of surface material or subgrade of surface facility or to finish grade.
- J. 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.
- K. Utility Structures:
 - 1. Storm drainage manholes, catch basins, drop inlets, curb inlets, cleanouts, vaults, etc.

1.6 SUBMITTALS

- A. Follow submittal procedure outlined in Division 1.
- B. Product Data:
 - 1. Grading and quality characteristics showing compliance with requirements for the Work.
 - 2. Certification from the soil supplier or an accredited laboratory that material meets requirements of the Project.
- C. Samples:
 - 1. If required by the Geotechnical Consultant and/or Landscape Architect, provide 40-pound samples of mixed bioretention soil 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 and/or Landscape Architect.
 - 2. Provide materials from same source throughout work. Change of source requires approval of the Geotechnical Consultant, Landscape Architect and the Owner's Representative's.
- D. Material Test Reports: Provide, from a qualified testing agency, the following test results showing compliance with the project requirements:
 - 1. Grain size analysis results of the fine sand component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
 - 2. Quality analysis results for compost performed in accordance with TMECC (Seal of Testing Assurance (STA) standards).
 - 3. Organic content test results of mixed Bioretention Soil in accordance with Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
 - 4. Grain size analysis results of compost component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
 - 5. Tests must be conducted within 120 days prior to the delivery date of the bioretention soil to the project site.
 - 6. Laboratory compaction curve in conformance with ASTM D 1557 for each imported backfill material.

1.7 QUALITY ASSURANCE

- A. Provide 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. Conform all work and materials to the recommendations or requirements of the Geotechnical Report and Landscape Architect and meet the approval of the Geotechnical Consultant and Landscape Architect.
- C. Conform all work to the appropriate portion(s) of the Caltrans Standard Specifications, Section 19.
- D. Material for bioretention facilities must be sufficiently permeable to infiltrate runoff at a minimum rate of 5 inches per hour during the life of the facility and must provide sufficient retention of moisture and nutrients to support healthy vegetation.
- E. Material for bioretention facilities shall be free of inert materials and other deleterious substances.
- F. 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.
- G. The Geotechnical Consultant will perform observations and tests required to enable him to form an opinion of the acceptability of the placement of the bioretention soil mix. Correct the bioretention soil mix that, in the opinion of the Geotechnical Consultant, does not meet the requirements of these Technical Specifications and the Geotechnical Report.

1.8 PROJECT CONDITIONS

- A. Promptly notify the Owner's Representative of surface or subsurface conditions differing from those disclosed in the Geotechnical Report. First notify the Owner's Representative 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's Representative in writing of differing conditions prior to contractor starting work on affected items.
- B. Protect open, trenches, and excavations with fences, covers and railings to maintain safe pedestrian and vehicular traffic passage.
- C. Temporarily stockpile Bioretention Soil Mix material in an orderly and safe manner and in a location approved by the Owner's Representative.
- D. Provide dust and noise control in conformance with Division 1.

PART 2 PRODUCTS

2.1 BIORETENTION SOIL MIX

- A. General Requirements:
 - 1. The bioretention soil mix shall have a long term infiltration rate of 5 inches per hour.
 - 2. The bioretention soil mix shall consist of a mixture of fine sand and compost measured on a volume basis:
 - a. 60%-70% Sand
 - b. 30%-40% Compost
- B. Sand: Conform to ASTM C33 for fine aggregate.
 - 1. Clean and free of clay, silt, dust, organic material or any deleterious substances.
 - 2. All aggregate passing the No. 200 sieve shall be non-plastic (plasticity index < 12, per ASTM D 4318).
 - 3. Shall meet the following gradation (ASTM D 422):

Sieve Size	Percent Passing (by weight)	
	Min	Max
3/8"	100	100
No. 4	90	100
No. 8	70	100

No. 16	40	95
No. 30	15	70
No. 40	5	55
No. 100	0	15
No. 200	0	5

C. Compost Material: Shall be a well decomposed, stable, weed free, organic matter source derived from waste materials including yard debris, wood wastes or other organic materials not including manure or biosolids meeting the standards developed by the US Composting Council. The product shall be certified through the USCC Seal of Testing Assurance Program.

1. Feedstock Materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
2. Organic Matter Content: 35% - 75% by dry weight
3. Carbon and Nitrogen Ratio: C:N < 25:1 and C:N > 15:1.
4. Maturity/Stability: Shall have a dark brown color and a soil like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or with a temperature at or above 120°F upon delivery or rewetting is not acceptable. In addition any one of the following is required to indicate stability:
 - a. Oxygen Test < 1.3 O₂ / unit TS / hr
 - b. Specific oxy. Test < 1.5 O₂ / unit BVS
 - c. Respiration test < 8 C / unit VS / day
 - d. Dewar test < 20 Temp. rise (C)
 - e. Solvita® > 5 Index value
5. Toxicity: Any one of the following measures is sufficient to indicate non-toxicity.
 - a. NH₄- : NO₃-N < 3
 - b. Ammonium < 500 ppm, dry basis
 - c. Seed Germination > 80% of control
 - d. Plant Trials > 80% of control
 - e. Solvita® > 5 Index value
6. Nutrient Content: Provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S and B.
 - a. Total Nitrogen content 0.9% or above preferred.
 - b. Boron: Total shall be < 80 ppm; Soluble shall be < 2.5 ppm
7. Salinity: Must be reported; < 6.0 mmhos/cm
8. pH shall be between 6.5 and 8. [may vary with plant species]
9. Shall meet the following gradation (ASTM D 422):

Sieve Size	Percent Passing (by weight)	
	Min	Max
1"	99	100
1/2"	90	100
1/4"	40	90
No. 200	2	10

10. Bulk density: Between 500 and 1100 dry lbs/cubic yard.
11. Moisture Content: Between 30% - 55% of dry solids.
12. Inerts: Shall be free of inert material, including glass, plastic, paper and other deleterious substances (< 1.0% by weight or volume).
13. Weed seed pathogen destruction: Provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach min. 55C ofr 15 days with at least 5 turnings during that period.
14. Select pathogens: Salmonella < 3 MPN/4grams of TS, and Coliform Bacteria < 10000 MPN/gram.
15. Trace Contaminant Metals (Lead, Mercury, etc.): Product must meet US EPA, 40 CFR 503 Regulations.

PART 3 EXECUTION

3.1 TRENCHING AND EXCAVATION

- A. Excavate bioretention areas to the limits shown on plan.
- 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.
- 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/excavations that have been excavated below bedding design subgrade, with approved bedding material.
- F. Comply with the Owner's Representative's limitations on the amount of trench/excavation that is opened or partially opened at any one time. Do not leave trenches/excavations open overnight without the approval of the Owner's Representative.
- G. Where forming is required, excavate only as much material as necessary to permit placing and removal of forms.
- H. Bottoms of trenches/excavation will be subject to testing by Geotechnical Consultant. Correct deficiencies as directed by the Geotechnical Consultant.
- I. Avoid over-compaction of native soils in the area of the excavation. Delineate the bioretention facility area and keep construction traffic off. Protect soils as necessary with fencing, plywood, etc.
- J. Provide erosion control in the contributing drainage area and stabilize slopes and or walls of excavation. Excavations for bioretention facilities shall be kept free of sediment from eroded soils.
- K. Grade bottom of trench/excavations 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.
- L. Prepare the bottom of excavations to promote infiltration from bioretention soil mix to native soils (scarify upper 3").

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's Representative 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
- F. Dispose of collected groundwater in a lawful manner.

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'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 in trench section or around structures 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 line, grade, or backfill compaction or operation of the utility being installed or adjacent utilities and facilities.

3.4 BACKFILLING

- A. Obtain approval of bioretention soil mix from Geotechnical Consultant and/or Landscape Architect.
- B. If mixing bioretention soil mix onsite, use an adjacent impervious area or on plastic sheeting.
- C. Do not place or work bioretention soil if it is raining or the mix is saturated or raining.
- D. Bring rock backfill up simultaneously on both sides of the subdrain section, so as to prevent any displacement of the pipe from its true alignment. Carefully place and compact rock backfill material to an elevation of 12-inches above the top of the pipe in layers not exceeding 8-inches in loose thickness. Compact rock backfill material by vibratory equipment unless specified otherwise on the Plans or by the Geotechnical Consultant. Jetting or ponding of initial backfill material will not be permitted.
- E. Bring bioretention soil mix 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 subsequent backfill material at optimum water content to 85% relative compaction by book pack (walk around to firm) or wetting, unless specified otherwise on the Plans or by the Geotechnical Consultant. Jetting or ponding of subsequent backfill material will not be permitted.
- F. Do not use compaction equipment or methods that produce horizontal or vertical earth pressures which may cause excessive pipe displacement or damage the pipe.
- G. Bioretention soil mix backfill shall be inspected and tested by the Geotechnical Consultant and Landscape Architect during placement. Cooperate with the Geotechnical Consultant and Landscape Architect 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, the Landscape Architect and the Owner's Representative prior to proceeding with the Project.

3.5 CLEANUP

- A. Upon completion of bioretention facilities work 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's Representative.
- B. See Division 1 for further cleanup requirements.

END OF SECTION

**SECTION 320523
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 312300, Excavation and Fill
- B. Section 313119, Vegetation Control
- C. Section 321613, Concrete Curbs and Gutters
- D. Section 321723, Pavement Markings
- E. Section 330516, Utility Structures

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.
 - 4. C 94, Specification for Ready-mixed Concrete.
 - 5. C 114, Method for Chemical Analysis of Hydraulic Cement.
 - 6. C 150. Portland Cement.
 - 7. C 618, Fly Ash and Raw or Calcined Natural Pozzolan for use as Natural Admixture in Portland Cement.
 - 8. C 1751, Preformed Expansion Joint Fillers for Concrete. Paving and Structural Construction (Non-extruded and Resilient Bituminous Types).
- B. Caltrans Standard Specifications:
 - 1. Section 51: Concrete Structures.
 - 2. Section 73: Concrete Curbs and Sidewalks.
 - 3. Section 90: Portland Cement Concrete.

1.4 DEFINITIONS

- A. ASTM: American Society for Testing and Materials.

1.5 SUBMITTALS

- A. Follow submittal procedures outlined in Section 013300 – 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.

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.

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 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.
- B. Cement for Surface Improvements: Provide a coloring equivalent to ¼ pound of lampblack per cubic yard. Add to the concrete at the central mixing plant.
- C. Liquiblack, as supplied by Concrete Corporation of Redwood City, California, may be used in lieu of lampblack. One pint of liquiblack shall be considered equal to one pound of lampblack.

2.2 AGGREGATE AND AGGREGATE GRADING

- A. General: Conform to the requirements of Section 90-2.02, 2.02A and 2.02B of the Caltrans Standard Specifications.
- B. Aggregate Size and Gradation: Conform to the requirements of section 90-3 of the Caltrans Standard Specifications for 25-mm (1-inch) maximum combined aggregate.

2.3 WATER

- A. General: Conform to the requirements of section 90-2.03 of the Caltrans Standard Specifications, for mixing and curing portland cement concrete and for washing aggregates.

2.4 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:
1. Vehicular Pavement: Class 2.
 2. Curbs, Gutters, and Sidewalks: Minor Concrete.
 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.
 6. Water, Storm, and Sanitary Structures: The concrete shall consist of a minimum of 564 pounds of Portland cement per cubic yard of concrete.

2.5 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:
1. Curbs, Curb Ramps, Island Paving, Sidewalks, Driveways and Gutter Depressions: ¼-inch.
 2. Concrete Slope Protection, Gutter Lining, Ditch Lining and Channel Lining: ½-inch.
 3. Structures: As indicated.

2.6 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.

2.7 COLOR AND PATTERN FOR DECORATIVE SURFACES

Not Used.

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 90-7.01B, of the Caltrans Standard Specifications.

2.9 FORMS

- A. Conform to the requirements of Section 51-1.05 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

Not Used.

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 313119 – 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: 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 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 90-7.01B, 7.01D and 7.03 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 73-1.04 and 73-1.05A 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. Concrete walkway surfaces with a slope of less than 6.0% shall be at least as slip resistant as that described as a medium salted finish.
- D. Concrete walkway surfaces with a slope greater than 6.0% shall be at least as slip resistant as that described as a heavy salted finish.

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 73-1.04 and 73-1.06 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 DECORATIVE SURFACING CONSTRUCTION

- A. Decorative surfacing concrete walks, concrete median islands or other installations shall be formed and placed as a concrete slab conforming to the details shown or noted on the Plans.

3.16 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 Sections 73-1.05 and/or 73-1.06 of the Caltrans Standard Specifications.

3.17 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 321100
BASE COURSES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aggregate base.

1.2 RELATED SECTIONS

- A. Section 312300 – Excavation and Fill
- B. Section 321200 – Flexible Paving
- C. Section 320523 – Cement and Concrete for Exterior Improvements
- D. Section 321613 – Concrete Curbs and Gutters

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.
 - 2. E 329, Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
 - 3. E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.
- 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 $\frac{3}{4}$ -cubic yards or more in volume that when tested by an independent geotechnical testing agency, 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 Division 1.
- 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 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 24-1.04 of Caltrans Standard Specifications.
- F. Finish surface of the stabilized material after lime treatment shall be as specified in Section 24-1.08 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 feet.

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 BASE

- A. Material: Caltrans Standard Specification Section 26.
 - 1. Class 2, 3/4-inch Maximum: Section 26-1.02A.

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 BASE

- A. Watering, Spreading and Compacting: Section 26-1.035, 26-1.04 and 26-1.05 of Caltrans Standard Specifications.

3.4 DISPOSAL

- A. Lawfully dispose of all unsuitable and excess or surplus material off-site at no cost to the Owner.

END OF SECTION

**SECTION 321200
FLEXIBLE PAVING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Prime coat.
- B. Tack coat.
- C. Asphaltic concrete paving.
- D. Asphaltic concrete overlay.
- E. Slurry seals.
- F. Speed bumps.
- G. Asphalt curbs.
- H. Pavement grinding.

1.2 RELATED SECTIONS

- A. Section 313119 – Vegetation Control
- B. Section 321100 – Base Courses

1.3 RELATED DOCUMENTS

- A. Geotechnical Report.
- B. ASTM:
 - 1. D 979: Practice for Sampling Bituminous Paving Mixtures.
 - 2. D 1073: Specification for Fine Aggregate for Bituminous Paving Mixtures.
 - 3. D 1188: Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens.
 - 4. D 2041: Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - 5. D 2726: Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
 - 6. D 2950: Test Method for Density of Bituminous Concrete in Place by Nuclear Method.
 - 7. D 3549: Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
 - 8. D 3666: Specifications for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Mixtures.
- C. Caltrans Standard Specifications.
 - 1. Section 37: Bituminous Seals.
 - 2. Section 39: Asphalt Concrete.
 - 3. Section 88: Engineering Fabrics.
 - 4. Section 92: Asphalts.
 - 5. Section 93: Liquid Asphalts.
 - 6. Section 94: Asphaltic Emulsions.

1.4 DEFINITIONS

- A. ASTM: American Society for Testing Materials.

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 Division 1.
- 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. Prime Coat: Minimum surface temperature of 60 deg F at application.
 2. Tack Coat: Minimum surface temperature of 60 deg F at application.
 3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at application.
 4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at application.
 5. 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 B.
- B. Asphalt Materials:
 1. Asphalt: Caltrans Standard Specification Section 92, steam refined paving asphalt.
 - a. Asphalt Curbs: use grade PG 70-10
 - b. All other asphalt products: use grade PG 64-10.
 2. Prime Coat: Caltrans Standard Specification Section 92, SC-70.
 3. Tack Coat: Caltrans Standard Specification Section 93, SS1.
 4. 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 39-2.02 as applicable.
- D. Storing, Proportioning and Mixing Materials: Caltrans Standard Specification Section 39-3.

- E. Pavement Reinforcing Fabric: Caltrans Standard Specification Section 88.
- 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 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 39-4.01.
- B. Prime Coat: Apply uniformly over surface of compacted-aggregate base according to the Caltrans Standard Specification Section 39-4.02. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure for 24 hours minimum.
 - 1. If prime coat is not entirely absorbed within 8 hours after application, spread excess prime coat with hand tools and broadcast sand over surface to blot excess asphalt. Use just enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- C. 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 39-4.02.
 - 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.

3.4 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.

3.5 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 39-4.03 of Caltrans Standard Specifications.

3.6 ASPHALTIC CONCRETE SPREADING AND COMPACTING EQUIPMENT

- A. Spreading Equipment: Caltrans Standard Specification Section 39-5.01.
- B. Compaction Equipment: Caltrans Standard Specification Section 39-5.02.

3.7 ASPHALTIC CONCRETE PLACEMENT

- A. Place, spread and compact asphaltic concrete to required grade, cross section, and thickness according to the Caltrans Standard Specification Sections 39-6.01, 39-6.02 and 39-6.03.
- 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.

3.8 JOINTS

- A. Construct joints to ensure continuous bond between adjoining paving sections according to the Caltrans Standard Specification Sections 39-6.01 and 39-6.02.
 - 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.

3.9 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 39-6.01 and 39-6.03.
- 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.

3.10 ASPHALT CURBS

- A. Construction: Place over compacted surfaces according to Caltrans Standard Specification Section 39-7.01 as specified for dikes. Apply a light tack coat prior to construction, unless pavement surface is still tacky and free of dust.
- B. Shape: Place asphaltic concrete to curb cross section indicated.

3.11 SPEED BUMPS

- A. Construct speed bumps over compacted pavement surfaces according to Caltrans Standard Specification Section 39-6. Apply a light tack coat prior to construction, unless pavement surface is still tacky and free of dust.
- B. Place asphaltic concrete by hand using a template/screed designed to result in speed bump cross-section indicated after compaction.
- C. Compact speed bumps with 8-ton static roller.

3.12 INSTALLATION TOLERANCES

- A. Asphalt Pavement:
 - 1. Course thickness and surface smoothness within the tolerances in the Caltrans Standard Specification Sections 39-6.01, 39-6.02 and 39-6.03.
 - 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 321320 SITE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide Portland cement concrete site work complete, including the following principal items:
 - 1. Retaining walls, stairs, planters, seat walls and benches.
 - 2. Curbs, walks and pavements, including aggregate bases.
 - 3. Footings for posts and structures.
 - 4. Curb ramps.

1.2 REFERENCES AND STANDARDS

- A. California Building Code and Americans with Disabilities Act Accessibility Guidelines (ADAAG) Access Requirements
- B. Perform work in accordance with all applicable laws, codes and regulations required by County of San Mateo.

1.3 TESTS

- A. The Owner's Representative will select a qualified testing laboratory to take samples for testing during the course of the work as considered necessary. Costs for such tests will be paid by the Owner's Representative. Contractor shall cooperate in arranging tests and shall be responsible for notifying the designated laboratory in sufficient time to allow taking of samples at time of pour.
- B. Should tests show that concrete is below specified strength, Contractor shall remove all such concrete, as directed by the Owner's Representative. Full cost of removal of low strength concrete, its replacement with concrete of proper specified strength and testing, shall be borne by Contractor.

1.4 SUBMITTALS

- A. Samples of all materials under this Division shall be supplied for testing as requested by the Owner's Representative.
- B. Material certificates in lieu of material laboratory test reports when permitted by Engineer. Material certificates shall be signed by manufacturer and Contractor certifying that each material item complies with or exceeds requirements. Provide certification from admixture manufacturers that chloride content complies with requirements.
- C. Submit color additive manufacturer's color chart and sample chip(s), indicate color additive number and required dosage rate.
- D. Submit full-scale mock-up (minimum 4' by 4') sample panels of all concrete finishes and color. The samples shall include curing compound if any is to be used, and include an expansion joint and a score joint, as indicated on the Drawings. Approved samples shall be kept at the job site to serve as a prerequisite for all finishes until acceptance of the Work.
- E. Submit one pint samples of aggregate for exposed aggregate finished concrete paving in color range as specified.

1.5 LEED SUBMITTALS

- A. Submit certification in a letter indicating percentages by weight of fly ash content for cast-in-place concrete.
- B. Submit product data highlighting percentages by weight of fly ash content for cast-in-place concrete.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Cement and aggregates shall have proven history of successful use with one another. Sources of cement and aggregate shall remain unchanged throughout work.
- B. Mixes:
1. Ready-mixed concrete shall meet requirements of ASTM C94.
 2. The Contractor shall perform tests or assemble the necessary data indicating conformance with specifications.
 3. For each mix, submit data showing that proposed mix will attain the required strength in accordance with requirements of Caltrans Standard Specifications, Section 90.
 4. Instruct Laboratory to base mix design on use of materials specified and approved by the Owner's Representative.
 5. Mix design shall include compression strength test reports per CBC Section 1905A.6.3.
 6. Insure mix designs will produce concrete to strengths specified and of uniform density without segregation.
 7. If mix yield exceeds 1-cubic yard, modify mix design to no more than one cubic yard, without changing cement content.
 8. Introduction of calcium chloride will not be permitted.
 9. Mix design shall be in accordance with CBC Section 1905A.3.

- C. Concrete Types (See Drawings for any other miscellaneous items not listed below):

TYPE	28-DAY STRENGTH	AGGREGATE SIZE	FINISH & COLOR	COMMENTS
Slab on grade	3,000	1" X #4	See Drawings	

2.2 FORMWORK MATERIALS

- A. Panel or board forms for Exposed Finish Concrete:
1. Minimum 5/8-inch thick exterior grade plywood with sealed edges, PS 1 grade Plyform Class I and II B-B Exterior.
- B. For Exposed Smooth Form-finished Concrete:
1. Use Medium Density (or better) Overlaid Concrete Form Exterior (MDO), to provide continuous straight, smooth, exposed surfaces without grain patterns. Furnish in largest practicable sizes to minimize number of joints and to conform to a joint system as approved by Owner's Representative.
- C. Curbs may be formed with approved metal form systems.
- D. Form Release Agent:
1. Must not stain or otherwise adversely affect architectural concrete surfaces. "Nox-Crete Form Coating"; Industrial Synthetics Corp.'s "Synthex"; or approved equal.
 2. If form liner is being used, form release agent shall comply with form liner manufacturer's recommendations.
- E. Form Ties:
1. Burke "Penta-Tie," or approved equal, cone and rod type with 1-inch break-back.
 2. Form Ties shall not be used on exposed concrete walls less than 24" tall from Top of Wall to Finished Grade.

2.3 REINFORCING MATERIALS

- A. New, free of rust, Billet steel bars: Current ASTM designation A615.
- B. Bar Reinforcement: ASTM A615.
1. #3 and smaller: Grade 40.
 2. #4 and larger: Grade 60.
 3. Tie wire: #6 minimum, black and annealed.

- C. Bar Reinforcement recycled content shall be a minimum of 75% recycled post consumer steel.
- D. Wire Fabric Reinforcement: ASTM A185. Size (6" by 6" / W1.4 By W1.4 (#10 ga. by #10 ga.)
- E. All reinforcing steel, bolts anchors, sleeves, etc. shall be securely anchored in place before concrete is placed. All reinforcing details, fabrication and installation shall conform to ACI Standard 315, latest edition, except as noted. Stagger all splices where practical and not otherwise detailed. Minimum concrete protection for reinforcement shall be as follows unless otherwise noted:
 - 1. 3" clearance where concrete is placed against the earth.
 - 2. 2" clearance where concrete is exposed to earth but placed in forms.
- F. Accessories: Metal and plaster spacers, supports, ties, etc. as required for spacing, assembling and supporting reinforcing in place. Legs of accessories to be of type that will rest on forms without embedding into forms. Galvanized metal items where exposed to moisture, or use other approved non-corrodible, non-staining supports.

2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150, Type II, except if water or soil is high in sulfates use Type V Portland Cement as described above under Quality Assurance. Use one brand of cement throughout project.
- B. Fly Ash: ASTM C618,08A.
- C. Aggregates: ASTM C33, materials from established sources with proven history of successful use in producing concrete with minimum shrinkage.
- D. Aggregate for seeded aggregate finish paving: Submit samples for approval as specified herein.
- E. Aggregate for washed exposed aggregate finish paving shall consist of 3/4" by #4 smooth, hard, fine-grained clean, river run aggregate. Submit samples for approval as specified herein.
- F. Water: Clear and potable, free from deleterious impurities.
- G. Admixtures:
 - 1. Admixtures are optional; however, a water reducer or plasticizing admixture shall be included in the concrete mix and it must be compatible with color pigments where color pigments are required. Any proposed admixture shall comply with ASTM C494.
 - 2. Where more than one admixture is proposed, include statement from admixture manufacturer indicating that admixtures proposed for use are compatible, such that desirable effects of each admixture will be realized.
 - 3. Accelerating admixtures and admixtures containing more than 0.05 percent chloride ions are not permitted. If an accelerator is used, it shall be a non-chloride accelerator.
 - 4. Liquid admixtures shall be considered part of the total water.
 - 5. Refer to Color Additives/Pigments herein for color admixtures.
- H. Color Additives/Pigments: Insoluble minerals, light fast, at least 95 percent passing #325 sieve complying with ASTM C979: Davis Colors, Los Angeles, CA (800) 356-4848; L.M. Scofield Co., Los Angeles, CA (800) 800-9900; or approved equal. Color(s) shall be as follows:
 - 1. Davis # 6455
 - 2. Color additives containing carbon black are not acceptable

2.5 CONCRETE MIXES

- A. Concrete mixes shall be approved and shall be in accordance with Caltrans Standard Specifications Section 90. Unless otherwise noted, mix shall contain not less than 590 pounds of cementitious material per cubic yard (Class "2", 3,000 psi,) Type II Portland cement and a maximum aggregate blend of 1" by #4.

- B. Cementitious Material: An intimate blend of type II Portland cement and fly ash. Cementitious material shall include 15% maximum fly ash by weight unless the strength is specified to be achieved on 7 or 14 days.
- C. Matching existing colored concrete work: Mixes for matching existing paving shall be as required to match specified items on site using specified integral color pigments at required rates per 94 pounds of Portland cement. Submit integrally colored sample(s) per Submittals herein.
- D. Lampblack: As supplied by batch plant for plain non-colored concrete work. Concrete for non-colored pavements shall be darkened by the addition of lampblack at the mixer. The proportion of lampblack or other approved colorant shall be that required to properly darken the concrete to reduce glare, and shall be subject to the approval of the Owner's Representative. Provide $\frac{3}{4}$ pound of lampblack per cubic yard of concrete unless required otherwise.

2.6 ANCILLARY MATERIALS

- A. Aggregate Base: Crushed aggregate, R-78 minimum, 3/4-inch maximum, conforming to Standard Specification 26.1.02A, Class 2.
- B. Expansion Joint Material
 - 1. Fiber Expansion Joint: A non-extruding resilient filler, saturated with high quality bituminous materials having preserving characteristics. Conform to ASTM-D1751-04.
- C. Dampproofing: Per CALTRANS Standard Specifications, Section 54.
- D. Subsurface Drain behind Retaining-Type Walls: All concrete walls that retain 30 inches of soil or more shall include a subsurface drainage system to relieve water pressure in accordance with Section 68 of the CALTRANS Standard Specifications and as shown. If no subsurface drain is shown, provide corrugated polyethylene plastic tubing per 68-1.02K surrounded with an envelope of Class 2 permeable material in conformance to Section 68 "Subsurface Drains" of the Standard Specifications, 3/4 inch maximum without fines and wrapped with filter fabric per 68-1.028. Provide black colored rodent-proof slotted cap over exposed outfalls as accepted by Owner's Representative.
- E. Curing Materials for non-colored Concrete:
 - 1. Waterproof Paper: ASTM C171, Type 1.1.1.1, regular. Same as Sisalkraft Division of St. Regis Paper Co.'s "Orange Label", or approved equal.
 - 2. Impervious sheeting: 4 mil white polyethylene laminated to 10 oz. Burlap, ASTM C171, Type 1.1.3, fungus-resistant.
 - 3. Curing Compound: ASTM C309. Product: Sealtight 1100 Clear-Series by WR Meadows, Burke Azua Resin Cure by Edocol, or approved equal that will not discolor concrete or affect bonding of other finishes applied thereafter, and which restricts loss of water to not more than 0.500 grams per sq. centimeter of surface when tested per ASTM C156, "Test Method for Water Retention by Concrete Curing Materials."
- F. Curing Compound for Colored Concrete: Water-base acrylic type, free of permanent color, oil or wax, complying with ASTM C309: "W 1000" by Davis Colors, Los Angeles, CA (800) 356-4848; "Cureseal" semi-gloss by L.M. Scofield Co., Los Angeles, CA (800) 800-9900; or approved equal.
- G. Grout: Premixed high strength non-shrink grout requiring only addition of water at the site. Burke's "Non-Ferrous, Non-Shrink Grout"; Master Builders "Masterflow 928 Grout", or approved equal.
- H. Patching Mortar: Mix in proportions by volume of one part cement to two parts fine sand. Provide integrally colored patching mortar as required to match color and finish of colored concrete surfaces.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install all concrete work true to line and grade as indicated on the drawings.
- B. Correct irregularities to the satisfaction of the Owner's Representative.
- C. Plain non-colored, exposed concrete shall contain lampblack, approximately 3/4 pound of lampblack per cubic yard, as accepted by Owner's Representative.
- D. The intent of the Grading Drawings is to provide positive drainage and to maintain slopes on walkways as required by the Americans with Disabilities act and California Title 24 throughout the project site. Notify the Owner's Representative immediately of any discrepancies between the Drawings and actual field conditions and/or conflicts between the design and Code requirements.

3.2 PREPARATION

- A. Examine subgrades and installation conditions. Do not start concrete work until unsatisfactory conditions are corrected.
- B. Provide subgrade preparation and the base material installation complete, including clearing, grading, excavation, filling and dewatering. Take every precaution to obtain a subgrade of uniform bearing power compacted to a minimum of 95% relative compaction as determined by the ASTM D1557 laboratory test procedure and in Sections 19 and 20 of the Caltrans Standard Specifications.
- C. Subgrade shall be kept moist and shall not be allowed to dry out before placement of concrete. Place no material on muddy subgrade. Remove un-compactable material and replace with clean fill and compact as required.
- D. Aggregate base, where indicated, shall be placed and compacted in conformance with Caltrans Standard Specifications 26-1.04 and 26-1.05.
- E. Obtain approval of subgrade from Owner's Representative prior to placing steel and concrete.

3.3 FORMS

- A. Forms shall be constructed in accordance with ACI 318, Section 6.1 and shall be of sufficient strength and sufficiently tight to prevent visible distortion or leakage of mortar and fines.
- B. Forms for exposed surfaces shall be constructed to protect intended finish. Deflection of facing material between studs shall not exceed 0.0025 of the span. Facing material and pattern of joints shall be as approved by the Owner's Representative.
- C. For vertical surface of wall footings below grade, clean cut trench may be used in lieu of form if character of soil will permit installation without sluffing and width of concrete is increased at least 1 inch beyond indicated dimension of each face poured against earth.
- D. Curb and pavement edge forms shall extend full depth of concrete and shall be coordinated with installation of planting root barriers where required. Curves shall be formed with flexible metal or wood made up of thin laminations. Curve forms shall extend one stake space straight beyond tangent point. Where curbs and pavement are adjacent to areas to receive root barriers, provide smooth uniform edges. Remove any excess concrete as required to allow installation of root barriers without gaps between curbs and/or pavement and barriers.
- E. Maintain forms within the following tolerances.
 - 1. Top of Form: Plus or minus 1/8 inch in 10 feet and no abrupt variations; at required elevation to plus 3/8 inch.
 - 2. Face of Form: Plus or minus 1/4 inch in 10 feet longitudinal and no abrupt variations; perpendicular to surface plus or minus 1/8 inch.
- F. Form Ties: Align form ties as accepted by Owner's Representative. Obtain approval of form work from Owner's Representative prior to placing concrete.

- G. Forms may be reused upon cleaning and coating with parting compound to ensure separation from concrete without damage.
- H. After concrete is placed, the following minimum times shall elapse before removal of forms.
 - 1. Walls and benches: 48 hours.
 - 2. Footing sides: 24 hours.
 - 3. Curbs: 1 hour

3.4 REINFORCEMENT

- A. All concrete footings, walls, grade-beams shall be steel reinforced unless specifically noted to be "not reinforced." If no reinforcement is shown, reinforce in same manner as that shown in similar places or as accepted by Owner's Representative.
- B. Fabricate and place reinforcement as indicated on the Drawings and in accordance with ACI "Detailing Manual" SP-66. No reinforcement shall be placed prior to distribution of the approved shop drawings.
- C. Secure reinforcement in position by suitable supports and by wiring at intersections with tie wire. Supports shall be of sufficient number and strength to resist crushing or displacement under full load. Metal shall not extend to surface of concrete.
- D. At time of placing concrete, reinforcing shall be free of excessive rust, mill scale, or other bond reducing matter. Immediately before placing concrete, check and adjust position, support and anchorage.

3.5 CLEANING, PATCHING AND DEFECTIVE WORK

- A. Where concrete is under strength, out of line, level or plumb, or shows objectionable cracks, honeycombing, rock pockets, voids, spalling, exposed reinforcement, signs of freezing, mismatched color, or is otherwise defective, and, in the Owner's Representative's judgment, these defects impair proper strength or appearance of the work, the Owner's Representative will require its removal and replacement at the Contractor's expense.
- B. Immediately after stripping and before concrete is thoroughly dry, patch minor defects, form-tie holes, honeycombed areas, etc., with patching mortar colored and textured to match concrete. Remove ledges and bulges.
- C. Compact mortar into place and neatly file defective surfaces to produce level, true planes. After initial set, dress surfaces of patches mechanically or manually to obtain same texture as surrounding surfaces.
- D. Rock Pockets:
 - 1. Cut out to full solid surface and form key.
 - 2. Thoroughly wet before casting mortar.
 - 3. Where the Owner's Representative deems rock pocket too large for satisfactory mortar patching as described, cut out defective section to solid surface, and replace.
- E. Cleaning
 - 1. Insure removal of bituminous materials, form release agents, bond breakers, curing compounds, if permitted and other materials employed in work of concreting that would otherwise prevent proper application of sealants, liquid waterproofing, and other delayed finishes and treatments.
 - 2. Where cleaning is required, take care not to damage surrounding surfaces or leave residue from cleaning agents.

3.6 MIXING AND PLACING CONCRETE

- A. Conform to applicable requirements set forth in Caltrans Standard Specifications Section 51-1.09 and Section 90.
- B. Mixes for integrally colored concrete shall have pigment added early enough to ensure complete dispersal and uniform color, but not less than 15 minutes before placing.

3.7 JOINTS AND GROOVES IN FLAT WORK

- A. Plane of joints shall be perpendicular to surface. Where new pavements join existing, joints shall align.
- B. Sawn Contraction Joints:
 - 1. General: Provide where shown. Saw cut straight, true, and uniform, 1/8 -inch wide and not less than 1/4 of slab thickness in depth , unless otherwise noted. Cut with a power saw fitted with an abrasive or diamond blade.
 - 2. Commence saw cutting operations after concrete has cured long enough to resist damage by the saw cutting operations and early enough to avoid random contraction cracks.
 - 3. Contractor shall coordinate form removal and sequencing of adjacent concrete placement to minimize unnecessary saw cutting of adjacent surfaces.
 - 4. Contractor shall plan for the use of varying types of saw cutting apparatus to provide acceptable finishes in areas limited in accessibility.
 - 5. Fill saw cut over-runs and inadvertent saw cutting of adjacent surfaces with cement mortar to match color and finish of sawn pavement.
 - 6. If the joint pattern is not shown, provide joints not exceeding 6 feet in either direction and located to conform to column centerlines, wall corners, etc. as accepted by Owner's Representative.
- C. Tooled Joints / Score Joints
 - 1. Form joints in fresh concrete using a jointer to cut the groove so that a smooth, uniform impression is obtained to 1/4 depth of pavement unless shown otherwise.
 - 2. All joints shall be struck before and after brooming. Tool concrete both sides of joint.
 - 3. If joint pattern is not shown, provide joints not exceeding 6 feet in either direction and located to conform to column centerlines, wall corners, etc. as accepted by Owner's Representative.
- D. Expansion Joints in Flat Work: Provided at the location and intervals as shown on the drawings, and at all locations where concrete paving abuts buildings, curbs, walls, columns, or other structures, and not more than 16 feet on center. Specified and shown joint material shall be placed with top edge 1/8" below the paved surface, and shall be securely held in place to prevent movement. Joint and other edges shall be formed in the fresh concrete using an edging tool to provide a smooth uniform impression. All edges shall be struck before and after brooming.
- E. Sealed Joints: After the curing period, expansion joints shall be carefully cleaned and filled with approved joint sealant to just below adjacent paved surface in such a manner as to avoid spilling on paved surfaces or overflowing from joint.

3.8 FINISHING

- A. Flatwork and Curbs
 - 1. Surface Finishes
 - a. Float Finish (typical preliminary finishing for slabs to receive other finishes): The surface of the slab shall be screeded and all surface water and laitance removed. Floating shall be started as soon as the screeded surface has stiffened sufficiently. Floating shall be performed by hand using a wood float and shall be the minimum necessary to produce a relatively smooth, level, even-textured surface.
 - b. Heavy Broom Finish (typical for paving bands): After the slab has been float finished as described above, the surface shall be uniformly directional textured by coarse stable broom to match approved sample.
 - c. Medium Broom Finish: Obtain by drawing a stiff bristled broom across a floated finish for a nonslip surface. Perform brooming while concrete is still wet enough to receive broom marks to match approved sample. Direction of brooming to be perpendicular to direction of work or as otherwise shown on the drawings.
 - d. Brush Finish (typical for curbs): After the front form is removed, exposed surface shall be troweled smooth and then given a uniform light texture with fine brush parallel to line of curb, to match approved sample.

- e. Sand Finish: Washed and finish shall be achieved by rubbing with bristle brush and flooding surface so that concrete fines are exposed slightly and resultant surface is similar to medium grit sandpaper.
- f. Seeded Aggregate Finish: Evenly distribute specified aggregate over the surface with minimum surface voids. After the aggregate is thoroughly embedded, the surface shall be hand floated so that all aggregate is entirely embedded just beneath the surface. As soon as the concrete has achieved a firm set, begin simultaneously brushing and hosing with water so as to obtain a clean, uniform surface with no stone exposed more than 1/16". Care shall be taken so as to not dislodge or unevenly expose the seeded aggregate. Do not use a pressurized nozzle in washing the surface and avoid direct hosing of the surface.
- g. Washed Exposed Aggregate Finish:
 - 1) Place concrete using specified aggregate/concrete mix, screed tamp and bull float to desired elevation. A compatible water-reducing retarding admixture may be added in warm weather if desired. Apply surface retardant as soon as screeding and floating is complete.
 - 2) If concrete is pumped into forms, lightly top seed surface of concrete with additional 3/8" size aggregate as required to match approved sample.
 - 3) Cover slab with acceptable curing cover to prevent drying out. If fog cure is employed, start no sooner than recommended by retardant manufacturer.
 - 4) Check retarded surface at regular intervals to determine optimum time for removing retarded surface mortar.
 - 5) Broom and wash aggregate surface to remove mortar to its optimum (approximately 1/8" to 1/16" at surface stone depth) to match sample.
 - 6) After aggregate is exposed, proceed with proper curing.
- h. Steel Trowel Finish: After surface water disappears and floated surfaces sufficiently hardened, steel trowel and retrowel to smooth surface. After concrete has set enough to ring trowel, retrowel to a smooth uniform finish free of trowel marks or other blemishes. Avoid excessive troweling that produces burnished areas.
- i. Sandblast Finish: Perform in as continuous an operation as possible, utilizing the same work crew to maintain continuity of finish.
- j. Use an abrasive grit of the proper type and gradation to expose the aggregate and surrounding matrix surfaces to match sample panel, as follows:
 - a) Light Cut: approximately 1/16" depth
 - b) Medium Cut: approximately 1/8" to 3/16" depth
 - c) Heavy Cut: approximately 1/4" to 5/16" depth
- k. Blast corners and edge of patterns carefully, using backup boards in order to maintain a uniform corner of edge line.
- l. Use same nozzle, nozzle pressure and blasting technique as used for sample panel.
- m. Maintain control of abrasive grit and concrete dust in each area of blasting. Clean up and remove all expended abrasive grit, concrete dust and debris at the end of each day of blasting operations.
- n. Salt Finish: Screed, tamp and float concrete under normal installation procedures. While concrete is still in a plastic state, evenly dispense coarse grain rock salt over surface at the rate of 10 lbs. per 150 square feet to match approved sample. Carefully tamp and float in rock salt to depress it into concrete, but do not cover the salt grains. Allow concrete to set and cure thoroughly.
- o. Abrasive Finish: tamp and float concrete under normal installation procedures. While concrete is still in a plastic state, evenly dispense specified Abrasive Grains over surface at the rate of 1/4 lb. per square foot. Carefully tamp and float in Abrasive Grains to depress grains into concrete, but do not cover grains. Allow concrete to set and cure thoroughly under normal procedure.

3.9 DAMPPROOFING

- A. Mop apply one heavy coat of asphalt dampproofing to soil side of retaining walls and planter walls from top of wall footing to a minus 2 inches below finished soil grade.

3.10 CURING

- A. Cure non-colored exposed concrete in accordance with Caltrans Standard Specifications Section 90-7.
- B. Cure colored exposed concrete using Curing Compound for Colored Concrete as specified herein.
- C. When applying Curing Compound, apply after initial set of fresh concrete when bleed water has evaporated from surface using a "Hudson-type" airless sprayer in accordance with manufacturer's specifications.
- D. Only water or curing compounds which impart no permanent color or gloss shall be used for curing concrete.

3.11 CLEANUP: Per Section 01 74 00.

END OF SECTION

**SECTION 321545
STABILIZED DECOMPOSED GRANITE PAVING**

 New Section, August 26, 2016

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide decomposed granite (DG) paving stabilized with copolymer as indicated on the drawings and as specified herein.
- B. Related work not specified in this Section.
 - 1. SECTION 32 20 21, SUBGRADE PREPARATION AND BASEROCK.

1.2 QUALITY ASSURANCE

- A. Reference Standards
 - 1. PERFORM ALL WORK IN ACCORDANCE WITH ALL APPLICABLE LAWS, CODES AND REGULATIONS REQUIRED BY COUNTY OF SAN MATEO.
 - 2. CALIFORNIA BUILDING CODE AND AMERICANS WITH DISABILITIES ACT ACCESSIBILITY GUIDELINES (ADAAG) ACCESS REQUIREMENT
 - 3. REFERENCE TO "STANDARD SPECIFICATIONS" SHALL MEAN THE STANDARD SPECIFICATIONS OF THE STATE OF CALIFORNIA, BUSINESS AND TRANSPORTATION AGENCY, DEPARTMENT OF TRANSPORTATION, CALTRANS.
- B. Stipulations: At no point shall surface fail to drain. Any Decomposed Granite that has a surface slope of 3 % and greater shall be Stabilized.
- C. Copolymer treated decomposed granite can permanently stain concrete and other masonry surfaces. Protect adjacent pavement, curbs, etc. from contact with decomposed granite. Remove any spillover immediately.
- D. Stabilized DG paving shall be installed so as to create a firm, stable slip-resistant surface.

1.3 SUBMITTALS: Per Section 01 33 00.

- A. Copolymer/Granite Mix: Submit a 6-foot-square sample of copolymer-treated decomposed granite in the field along with a copolymer mix design which states the proportions and recommended application rates. The design intent is to provide a consistent, stabilized, full lift of decomposed granite surface as specified and as shown on the drawings and without changing the color of the decomposed granite after it cures.
- B. Copolymer: "Organic Based Soil Stabilizer" is not acceptable in lieu of polyvinyl acrylic copolymer. Contractor shall furnish, if requested, signed copies of a compliance statement certifying that the copolymer complies with the specifications including weight per gallon, solids, pH, trade name of copolymer and gallons purchased.

PART 2 - MATERIALS

2.1 BASE

- A. Crushed rock conforming with Class 2 standards of Section 26, 1.02 A of Caltrans Standard Specifications, ¾ " maximum.

2.2 ROCK SURFACE

- A. Clean, hard, durable particles of 3/8" minus select crushed granite. Fines shall be evenly mixed throughout the aggregate. When produced from gravel, 50% of the material by weight retained on a No. 4 sieve shall have one fractured face. Material shall be Trade name "California Gold," available from Felton Quarry, Granite Construction Co. in Felton, CA, (831) 335-3445 or approved equal.
- B. The crushed aggregate screenings shall be free from clay lumps, vegetable matter, and deleterious material.
- C. Sand Equivalent (CT 217) of 25.
- D. Unit Weight - Maximum dry Density: 133 pcf
- E. Grading requirements for "Path Fines":
PERCENT OF WEIGHT PASSING A SQUARE MESH SIEVE
AASHTO T11-82 AND T27-82

SIEVE SIZE	% PASSING
3/8 INCH	100
NO. 4	85-100
NO. 8	56-80
NO. 30	30-45
NO. 200	10-20

2.3 WATER: Potable.

2.4 COPOLYMER

- A. Soilshield-LS polyvinyl acrylic copolymer colorless emulsion available from Soil-Loc, Inc., Scottsdale, Arizona, (888) 828-7300. The stabilizing agent shall be a nonflammable concentrated polyvinyl acrylic copolymer with a formulation containing a minimum of 60% solids that may be diluted for application at job site. After drying, the copolymer shall form a colorless, transparent micro-plastic like film to agglomerate particles and allow exchange of air and moisture. The product shall have a minimum effective service life of at least two years, provided surface is maintained according to manufacturer's recommendations. When cured, the copolymer emulsion shall not re-emulsify and shall be biodegradable and nontoxic to plant and animal life. After application and drying, a core of the treated section shall be able to maintain a portion of its shape, elasticity, and a portion of its strength after being submerged in water for a 24-hour period.
- B. Store material as recommended by manufacturer.
- C. The use of "Organic Stabilizers" such as Plantago, Pysllium Husk, Guar and Starches will not be accepted.

2.5 EDGES

- A. Except where edges are otherwise restrained by curbs, pavement, etc. provide 2 by 6 Redwood headerboard edging as specified in the Planting Specification or as shown or specified otherwise.

PART 3 - EXECUTION

3.1 PREPARATION

- A. General Grading: Excavate, fill and fine grade the decomposed granite areas and adjacent areas so that the paving has positive surface drainage and follows the required alignment with a minimum 2% slope and maximum 3% slope as approved by the Owner's Representative. All low areas shall be filled and the areas to be paved shall be above the surrounding finish grade after compaction to prevent water from standing on the paved surface.
- B. Prepare subgrade in accordance with Caltrans Section 26, Aggregate Bases. Compact subgrade to minimum 90% relative compaction to receive base rock. Compact base rock to 95% relative compaction.
- C. Prior to placing the decomposed granite, complete all earthwork, borders, header boards, and adjacent improvements.

3.2 INSTALLATION

- A. Over approved base rock, apply decomposed granite material loosely and evenly to required depths prior to application of copolymer. Screenshot the loosely graded material to the required grade so that after compaction, the compacted material will meet required thickness and finish grade.
- B. Apply copolymer evenly and uniformly to the loose, screeded material using approved sprayer at the rate recommended below.

3" Decomposed Granite Depth Stabilization

One (1) gallon concentrate per 60 square feet diluted with 14 to 20 parts water. The exact amount of water to be added to the concentrate depends on moisture level of the DG.

- C. Spray apply solution slowly enough to ensure full penetration with a minimum of two passes. Bow rake surfaces after first pass to reduce surface tension. Repeat applications until solution has percolated full depth of decomposed granite material to be stabilized. Rake and till as required between sprayed applications to thoroughly mix the solution evenly throughout the decomposed granite material. Verify full penetration of copolymer by hand sampling prior to compaction.
- D. Allow material to dry to compactable consistency (optimum moisture) and roll and compact with 1 – 3 ton roller or vibratory plate compactor to 90 percent relative compaction.
- E. Do not allow stabilizer treated DG to contact adjacent pavements or other surfaces. Provide protection of adjacent surfaces with plastic or other materials to prevent staining. Remove any stabilized DG from adjacent surfaces immediately upon discovery and correct any stain damage.
- F. After the pavement has cured for a minimum of 72 hours, remove excess material and dress the shoulders of the pavement. Fill low shoulders and fine grade as required and accepted by the Owner's Representative. Saw cut, remove and replace any unacceptable pavement as approved by Owner's Representative.

3.3 CLEANUP: Per Section 01 74 00.

END OF SECTION

**SECTION 321613
CONCRETE CURBS AND GUTTERS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Portland Cement Concrete curbs and gutters.

1.2 RELATED SECTIONS

- A. Section 312300 – Excavation and Fill
- B. Section 313119 – Vegetation Control
- C. Section 321100 – Base Courses
- D. Section 320523 – 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 Division 1.
- 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 be 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 320523 – 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:
 - 1. Curbs, Valley Gutters, Curb Ramps, Island Paving, Driveways and Gutter Depressions: 1/4-inch.

PART 3 EXECUTION

3.1 GENERAL

- A. Comply with requirements of Section 320523 – 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 73-1.04 and 73-1.06 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 40-1.04 of Caltrans Standard Specifications.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 FINISHING CONCRETE

- A. Finish curb and gutter in conformance with the applicable requirements of Section 73-1.04 and 73-1.05A 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. Concrete walkway surfaces with a slope of less than 6.0% shall be at least as slip resistant as that described as a medium salted finish.
- D. Concrete walkway surfaces with a slope greater than 6.0% shall be at least as slip resistant as that described as a heavy salted finish.

3.9 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.

3.10 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 1/2-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.

3.11 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 Sections 73-1.05 and/or 73-1.06 of the Caltrans Standard Specifications.

3.12 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 321713
PARKING BUMPERS**

PART 1 GENERAL

1.1 SUMMARY

- A. Provide materials, fabrication, and installation of parking wheelstops and associated accessory items.

1.2 SUBMITTALS

- A. Comply with requirements of Section 013300 – Submittals.
- B. Submit manufacturer's literature describing products and recommended installation details.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Section 016000 – Product Requirements.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Parking Wheelstops: Barco Products recycled plastic wheelstop, Model # WSTWHLSTP-DS, color grey, or equivalent.
- B. Disabled Parking Wheelstops: Barco Products recycled plastic wheelstop, model # WSTWHLSTP-PE, color blue, or equivalent.
- C. Fastening over Asphaltic Concrete Paving: Barco Products wheelstop hardware, set of 3 rebar, Model # HRDWR-ST, or equivalent.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine receiving surfaces and verify that surfaces are proper for installation.
- B. Do not start work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install parking wheelstops in accordance with manufacturer's recommendations using fasteners noted.
- B. Locate parking wheelstops accurately within parking spaces as indicated on Drawing.

END OF SECTION

SECTION 321723 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.

1.2 RELATED SECTIONS

- A. Section 320523 – 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:
 - 1. Plan A20A through A20D: Pavement Markers and Traffic Lines, Typical Details.
 - 2. Plan A24A and A24B: Pavement Markings Arrows.
 - 3. Plan A24C: Pavement Markings, Symbols and Numerals.
 - 4. Plan A24D: Pavement Markings, Words.
 - 5. Plan A24E: Pavement Markings, Words and Crosswalks.
 - 6. Plan A73A: Object Markers.
 - 7. Plan A73B: Markers.
 - 8. Plan A74: Survey Monuments.
 - 9. Plan RS1: Roadside Sign, Typical Installation Details No. 1.
- 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 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.

2.2 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.

2.3 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
 - 1. Non-reflective: Section 85-1.04 of Caltrans Standard Specifications.
 - 2. Retroreflective: Section 85-1.05 of Caltrans Standard Specifications.

2.4 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.
- E. Post Foundations: Portland cement concrete conforming to Section 32 05 23 – Cement and Concrete for Exterior Improvements.

2.5 STREET NAME SIGNS

- A. Conform to manufacturer, style, size, and shape shown on the Plans.
- B. Posts: Two (2) inch inside diameter steel pipe unless noted otherwise on the Plans. Conform to Section 56-2.02A of Caltrans Standard Specifications.
- C. Post Foundations: Portland cement concrete conforming to Section 32 05 23 – Cement and Concrete for Exterior Improvements.

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 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.

3.10 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 321726 TACTILE WARNING SURFACES

1.1 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 SECTION INCLUDES

- A. Cast In Place Detectable/Tactile Warning Surface Tiles.

1.3 RELATED SECTIONS

- A. Section 320523 – Cement and Concrete for Exterior Improvements

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- B. Samples for Verification Purposes: Submit two tile samples minimum 6" x 6" for each kind indicated.
- C. Shop drawings are required for products specified showing fabrication details, composite structural system, tile surface profile, sound on cane contact amplification feature, plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.
- D. Material Test Reports: Submit complete test reports from qualified accredited independent testing laboratory's to qualify that materials proposed for use are in compliance with requirements and meet or exceed the properties indicated on the specifications. All tests shall be conducted on a Cast In Place Detectable/Tactile Warning Surface Tile system as certified by a qualified independent testing laboratory and be current within a 24 month period.
- E. Maintenance Instructions: Submit copies of manufacturer's specified installation and maintenance practices for each type of Detectable Warning Surface Tile and accessory as required.

1.5 QUALITY ASSURANCE

- A. Provide Detectable/Tactile Warning Surface Tiles and accessories as produced, engineered and field tested products by a single manufacturer with a minimum of three (3) years experience in the manufacturing of Cast in Place Detectable/Tactile Warning Surface Tiles.
- B. Installer's Qualifications: Engage an experienced Installer certified in writing by Detectable/Tactile Warning Surface Tile manufacturer as qualified for installation, who has successfully completed installations similar in material, design, and extent to that indicated for Project.
- C. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (C
- D. CR) Title 24, Part 2, Section 205 definition of "Detectable Warning". Section 1117A.4 and 1127B.5 for "Curb Ramps" and Section 1133B.8.5 for "Detectable Warnings at Hazardous Vehicular Areas".
- E. Americans with Disabilities Act (ADA): Provide Detectable/Tactile Warning Surface Tiles which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title III Regulations, 28 CFR Part 36 ADA Standards For Accessible Design, Appendix A, Section 4.29.2 Detectable Warnings On Walking Surfaces).

1.6 DELIVERY, STORAGE AND HANDLING

- A. Detectable/Tactile Warning Surface Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.

- B. Detectable/Tactile Warning Surface Tiles shall be delivered to location at building site for storage prior to installation.

1.7 SITE CONDITIONS

- A. Environmental Conditions and Protection: Maintain minimum temperature of 40°F in spaces to receive Detectable/Tactile Warning Surface Tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.
- B. The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect the general public.

1.8 WARRANTY

- A. Cast In Place Detectable/Tactile Warning Surface Tiles shall be guaranteed in writing for a period of five (5) years from date of final completion. The guarantee includes defective work, breakage, deformation, fading and loosening of tiles.

1.9 SEQUENCING

- A. Coordinate with work as specified in Section 033000 "Cast-in-Place Concrete".

1.2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design: The design based on VPC Cast-in-Place Detectable/Tactile Warning Surfaces manufactured by Engineered Plastics Inc. Williamsville, NY tel (800-682-2525), www.armor-tile.com.

2.2 CAST-IN-PLACE DETECTABLE WARNING TILES

- A. Vitrified Polymer Composite (VPC) Cast in Place Detectable/Tactile Warning Surface Tiles shall be an epoxy polymer composition with an ultra violet stabilized coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an in-line pattern of truncated domes measuring nominal 0.2" height, 0.9" base diameter, and 0.45" top diameter, spaced center-to-center 2.35" as measured on a diagonal and 1.67" as measured side by side. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40 - 90° raised points 0.045" high, per square inch.
 1. Dimensions: Cast In Place Detectable/Tactile Warning Surface Tiles shall be held within the following dimensions and tolerances:
 2. Specifiers Note: Edit section below by selecting desired length and width. Delete non-relevant dimensions.
 3. Length and Width: 24x48 nominal, unless otherwise indicated.
 4. Depth: 1.375 (1-3/8") (+/-) 5% max.
 5. Face Thickness: 0.1875 (1-3/8") (+/-) 5% max.
 6. Warpage of Edge: 0.5% max.
 7. Embedment Flange Spacing: shall be no greater than 3.1"
 8. Color: Manufacturer's standard color, Charcoal Grey.
 9. Water Absorption of Tile when tested by ASTM D 570-98 not to exceed 0.05%.
 10. Slip Resistance of Tile when tested by ASTM C 1028-96 the combined Wet and Dry Static Co-Efficients of Friction not to be less than 0.80 on top of domes and field area.
 11. Compressive Strength of Tile when tested by ASTM D 695-02a not to be less than 28,000 psi.
 12. Tensile Strength of Tile when tested by ASTM D 638-03 not to be less than 19,000 psi.
 13. Flexural Strength of Tile when tested by ASTM D 790-03 not to be less than 25,000 psi.
 14. Chemical Stain Resistance of Tile when tested by ASTM D 543-95 (re approved 2001) to withstand without discoloration or staining - 10% hydrochloric acid, urine, saturated calcium chloride, black stamp pad ink, chewing gum, red aerosol paint, 10% ammonium hydroxide, 1% soap solution, turpentine, Urea 5%, diesel fuel and motor oil.

15. Abrasive Wear of Tile when tested by BYK - Gardner Tester ASTM D 2486-00 with reciprocating linear motion of $37 \pm$ cycles per minute over a 10" travel. The abrasive medium, a 40 grit Norton Metallite sand paper, to be fixed and leveled to a holder. The combined mass of the sled, weight and wood block is to be 3.2 lb. Average wear depth shall not exceed 0.060 after 1000 abrasion cycles when measured on the top surface of the dome representing the average of three measurement locations per sample.
16. Resistance to Wear of Unglazed Ceramic Tile by Taber Abrasion per ASTM C501-84 (re approved 2002) shall not be less than 500.
17. Fire Resistance of Tile when tested to ASTM E 84-05 flame spread shall be less than 15.
18. Gardner Impact to Geometry "GE" of the standard when tested by ASTM D 5420-04 to have a mean failure energy expressed as a function of specimen thickness of not less than 550 in. lbf/in. A failure is noted when a crack is visible on either surface or when any brittle splitting is observed on the bottom plaque in the specimen.
19. Accelerated Weathering of Tile when tested by ASTM G 155-05a for 3000 hours shall exhibit the following result – $\Delta E < 4.5$, as well as no deterioration, fading or chalking of surface of tile color No 33538
20. Accelerated Aging and Freeze Thaw Test of Tile and Adhesive System when tested to ASTM D 1037-99 shall show no evidence of cracking, delamination, warpage, checking, blistering, color change, loosening of tiles or other detrimental defects.
21. Salt and Spray Performance of Tile when tested to ASTM B 117-03 not to show any deterioration or other defects after 200 hours of exposure.
22. AASHTO HB-17 single wheel HS20-44 loading "Standard Specifications for Highways and Bridges". The Cast In Place Tile shall be mounted on a concrete platform with a 1/2" airspace at the underside of the tile top plate then subjected to the specified maximum load of 10,400 lbs., corresponding to an 8000 lb individual wheel load and a 30% impact factor. The tile shall exhibit no visible damage at the maximum load of 10,400 lbs.
23. Embedment flange spacing shall be no greater than 3.1" center to center spacing.

2.3 ACCESSORIES

- A. Fasteners: Color matched, corrosion resistant, flat head drive anchor: 1/4-inch diameter x 1 1/2-inch long as supplied by.
- B. Sealant: Sealant as supplied by manufacture.

1.3 EXECUTION

3.1 EXAMINATION & PREPARATION

- A. During Cast in Place Detectable/Tactile Warning Surface Tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.
- B. Prior to placement of the Cast in Place Detectable/Tactile Warning Surface Tile system, review manufacturer and contract drawings with the Contractor prior to the construction and refer any and all discrepancies to the Engineer.

3.2 CAST-IN-PLACE INSTALLATION

- A. The installation of the structural embedment flange system and related materials shall be in strict accordance with the contract documents and the guidelines set by their respective manufacturers. Not recommended for asphalt applications.
- B. The physical characteristics of the concrete shall be consistent with the contract specifications while maintaining a slump range of 4 to 7 permitting solid placement of the Cast In Place Detectable/Tactile Warning Surface Tile system. An overly wet mix will cause the tile to float. Under these conditions, suitable weights such as 2 concrete blocks or sandbags (25 lb) shall be placed on each tile.

- C. The concrete pouring and finishing operations require typical mason's tools, however, a 4' long level with electronic slope readout, 25 lb. weights, and a large non-marring rubber mallet are specific to the installation of the Cast in Place Detectable/Tactile Warning Surface Tile system. A vibrating mechanism such as that manufactured by Vibco can be employed, if desired. The vibrating unit should be fixed to a soft base such as wood, at least 1 foot square.
- D. The factory-installed plastic sheeting must remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.
- E. When preparing to set the tile, it is important that no concrete be removed in the area to accept the tile. It is imperative that the installation technique eliminates any air voids under the tile. Holes in the tile perimeter allow air to escape during the installation process. Concrete will flow through the large holes in each embedment flange on the underside of the tile. This will lock the tile solidly into the cured concrete.
- F. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, the electronic level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawings. The Cast In Place Detectable/Tactile Warning Surface Tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process should not be accomplished by stepping on the tile as this may cause uneven setting which can result in air voids under the tile surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.
- G. In cold weather climates it is recommended that the Cast In Place Detectable/Tactile Warning Surface Tiles be set deeper such that the top of domes are level to the adjacent concrete on the top and sides of ramp and that the base of domes to allow water drainage.
- H. Immediately after placement, the tile elevation is to be checked to adjacent concrete. The elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates. Ensure that the field surface of the tile is flush with the surrounding concrete and back of curb so that no ponding is possible on the tile at the back side of curb.
- I. While concrete is workable, a 3/8-inch radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.
- J. During and after the tile installation and the concrete curing stage, it is imperative that there is no walking, leaning or external forces placed on the tile that may rock the tile causing a void between the underside of tile and concrete.
- K. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Two suitable weights of 25 lb each may be required to be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.
- L. Following the concrete curing stage, protective plastic wrap is to be removed from the tile surface by cutting the plastic with a sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft brass wire brush will clean the residue without damage to the tile surface.
- M. If desired, individual tiles can be bolted together using 1/4-inch or equivalent hardware. This can help to ensure that adjacent tiles are flush to each other during the installation process. Tape or caulking can be placed on the underside of the bolted butt joint to ensure that concrete does not rise up between the tiles during installation. Any protective plastic wrap which was peeled back to facilitate bolting or cutting, should be replaced and taped to ensure that the tile surface remains free of concrete during the installation process.
- N. Tiles can be cut to custom sizes, or to make a radius, using a continuous rim diamond blade in a circular saw or mini-grinder. Use of a straightedge to guide the cut is advisable where appropriate.
- O. Any sound-amplifying plates on the underside of the tile, which are dislodged during handling or cutting, should be replaced and secured with construction adhesive. The air gap created between these plates and the bottom of the tile is important in preserving the sound on cane audible properties of the tile system as required.

3.3 CLEANING, PROTECTING AND MAINTENANCE

- A. Protect tiles against damage during construction period to comply with Tactile Tile manufacturer's specification.
- B. Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.
- C. Clean Tactile Tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean Tactile Tile by method specified by Tactile Tile manufacturer.
- D. Comply with manufacturers maintenance manual for cleaning and maintaining tile surface and it is recommended to perform annual inspections for safety and tile integrity.

END OF SECTION

SECTION 321813 SYNTHETIC LAWN SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. It shall be the responsibility of the successful synthetic grass contractor to provide all labor, materials, equipment and tools necessary for the complete installation of the synthetic grass turf field as indicated on the plans and as specified herein. The installation of all materials shall be performed in strict accordance with the manufacturer's installation instructions and in accordance with all approved shop drawings.
- B. Perimeter edge details required for the system shall be as detailed and recommended by the Manufacturer, and as approved by the Owner's Representative. Supply and installation of these details will be under the scope of work of the base contractor, not that of the artificial grass field turf Installer.
- C. The system shall consist of, but not necessarily be limited to, the following:
 - 1. A complete synthetic lawn system, consisting of not less than 2" inch long grass zone, 1.75" thatch zone (+/- 15%).

1.2 REFERENCES

A. ASTM Standard Test Methods:

- D1577 - Standard Test Method for Linear Density of Textile Fiber
- D5848 - Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Covering
- D418 - Standard Test Method for Testing Pile Yarn Floor Covering Construction
- D1338 - Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings
- D1682 - Standard Method of Test for Breaking Load and Elongation of Textile Fabrics
- D5034 - Standard Test Method of Breaking Strength and Elongation of Textile Fabrics (Grab Test)
- F1015 - Standard Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces
- D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
- F355 - Standard Test Method for Shock-Absorbing Properties of Playing Surfaces.
- F1936 - Standard Test Method for Shock-Absorbing Properties of North American Football
- D1557 - Test Method for Laboratory Compaction Characteristics of Soil

1.3 RELATED WORK ELSEWHERE

- A. Section 02310 Earthwork
- B. Section 02790 Permeable Sub-base

1.4 QUALIFICATIONS AND SUBMITTALS

- A. The turf contractor and installation company (if different) must provide competent workmen, skilled in this specific type of infill synthetic grass installation; they must have installed a minimum of 100 fields of 65,000 square feet or more with the same specific manufacturer/company and infill system that is being proposed for this project. The designated supervisory personnel on the project must be certified in writing by the turf manufacturer as competent in the installation of this material, including sewing seams and proper installation of the infill mixture. The manufacturer shall have a representative on site to certify the installation and warranty compliance.
- B. All designs, markings, layouts, and materials shall conform to all currently applicable High School, National Federation, NCAA and/or FIFA rules and other standards as specified that may apply to this type of synthetic grass installation.
- C. Prior to the bid and/or architect/Owner's Representative approval of a specified synthetic grass system, the manufacturer shall specify in writing that their turf system does not violate any other company/manufacturer's patents, patents allowed or patents pending.
- D. At least seven (7) days prior to the bid and/or architect/Owner's Representative approval of a specified artificial turf system, the company/manufacturer shall provide a copy of the 15-year minimum prepaid, non-prorated, third-party insured warranty and insurance policy information.
- E. Prior to the bid and/or architect/Owner's Representative approval of a specified artificial turf system, the company/manufacturer shall provide an audited company financial statement.
- F. The contractor shall provide evidence direct from the turf manufacturer stating the installer has complied with the requirements in above Section 2.02 and is certified by the manufacturer to install this type of synthetic grass.
- G. The contractor/manufacturer shall submit, prior to the bid, written documentation that verifies that both the ten fields installed in North America and the field they are proposing for this project contain the exact specified infill material, fiber type and backing. The product must utilize the exact same fiber type, infill system, backing and all other materials.

PART 2 PRODUCTS:

2.1 SYNTHETIC LAWN SYSTEM:

- A. Synthetic Lawn System shall be "SYNFescue 354" synthetic lawn system, available from SYNLawn, call (866-SYNLawn) or approved equal.
- B. A fifteen (15) year manufacturer's warranty is to be provided by the Synthetic Turf System company directly to the Owner's Representative/City as a part of this proposal. Contractor to ensure that this warranty is included in the Turf manufacturer's proposal. Contractor will assist the Owner's Representative/City in obtaining this warranty prior to final payment for the project.

3.0 PART 3 EXECUTION:

3.1 INSTALLATION PROCEDURES

- A. The turf contractor shall strictly adhere to the installation procedures outlined under this section. Any variance from these requirements must be accepted in writing by the manufacturer's onsite representative and submitted to the architect/Owner's Representative, verifying that the changes do not in any way affect the warranty.
- B. Verify that all sub-base, drainage and leveling is complete prior to installation.

- C. The surface to receive the synthetic turf shall be inspected by the Installer, and prior to the beginning of installation, the Installer must accept in writing the sub-base surface planarity and compaction- Provide written verification to Owner's representative. The surface must be perfectly clean as installation commences and shall be maintained in that condition throughout the process.
- D. The carpet shall be delivered in 15-foot wide rolls. The rolls shall be of sufficient length to span entire lawn. Head seams, between the sidelines, will not be acceptable.
- E. The carpet rolls are to be installed directly over the properly prepared aggregate base. Extreme care should be taken to avoid disturbing the aggregate base, both in regard to compaction and planarity. A 2-5 ton static roller shall be and available to repair and properly compact any disturbed areas of the aggregate base.
- F. The full width rolls shall be laid out across the long side of the lawn area. Utilizing standard state-of-the-art sewing procedures, each roll shall be attached to the next. When all of the rolls of the playing surface have been installed, the sideline areas shall be installed at right angles to the playing field turf.
- G. Within three months of completion of the field installation, the turf contractor shall provide the necessary initial testing data to the Owner's Representative that the finished field meets or exceeds the required shock attenuation.
- H. Thread for sewing seams of turf shall be as recommended by the synthetic turf Manufacturer.
- I. Glue and seaming fabric for inlaying lines and markings shall be as recommended by the synthetic turf Manufacturer.
- J. Synthetic turf shall be attached to the perimeter edge detail supplied and installed by others in accordance with the Manufacturer's standard procedures.

3.2 CLEANING RECOMMENDATIONS

- A. Protect installed synthetic turf from subsequent construction operations.
- B. Do not permit traffic over unprotected turf surface.
- C. Contractor shall provide the labor, supplies, and equipment as necessary for final cleaning of surfaces and installed items.
- D. All usable remnants of new material shall become the property of the Owner's Representative.
- E. The Contractor shall keep the area clean throughout the project and clear of debris.
- F. Surfaces, recesses, enclosures, etc., shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner's Representative.

3.3 PROJECT CLOSEOUT

- A. MAINTENANCE & WARRANTY: The turf installer and/or the turf manufacturer must provide the following:
 - 1. Upon receipt of the completed certificate of completion, the turf manufacturer shall provide a non-prorated, up-front pre-paid, third-party insured 15-year non-prorated warranty issued by an A Best rated insurance carrier. to the Owner's Representative that covers defects in materials and workmanship of the turf for a period of 15 years from the date of Substantial Completion. The turf manufacturer must verify that their onsite representative has inspected the installation and that the work conforms to the manufacturer's requirements. Turf manufacturer will supply evidence that the policy is in effect, fully funded and that the installation is added to the policy upon completion and acceptance.

2. The manufacturer's warranty shall include general wear and damage caused from UV degradation. The warranty shall specifically exclude vandalism and Acts of God beyond the control of the Owner's Representative or the manufacturer.
3. The turf contractor shall provide a warranty to the Owner's Representative that covers defects in the installation workmanship, and further warrant that the installation was done in accordance with both the manufacturer's recommendations and any written directives of the manufacturer's onsite representative.
4. All turf warranties shall be NON PRORATED and limited to repair or replacement of the affected areas, at the option of the manufacturer, and shall include all necessary materials, labor, transportation costs, etc. to complete said repairs. All warranties are contingent on the full payment by the Owner's Representative of all pertinent invoices.
5. Turf must maintain an ASTM 355 G-max of less than 170 for the life of the warranty.
6. Turf manufacturer must supply one groomer.
7. The Turf Contractor will train the Owner's Representative's facility maintenance staff in the use of the Turf Manufacturer's recommended Groomer within three (3) months after completion of the installation process.

END OF SECTION

**SECTION 323116
ORNAMENTAL FENCES & GATES**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide fencing and gates complete including footings and wood facing on stainless steel metal-framed gates and excluding automatic vehicular gates.
- B. Related requirement specifications elsewhere:
 - 1. Section 057005, Landscape Metalwork
 - 2. Section 062010, Site Carpentry
 - 3. Section 321320, Site Concrete

1.2 QUALITY ASSURANCE

- A. Comply with the latest publications for materials and operations of the following:
 - 1. "Code of Arc and Gas Welding in Building Construction" of American Welding Society, WS D1.0, latest edition with current supplements and addenda, is hereby made a part of this Section and Miscellaneous Metalwork shall conform to the applicable requirements therein, except as otherwise specified herein or shown on the drawings. Nothing contained herein shall be construed as permitting work that is contrary to code requirements or governing rules and regulations.
 - 2. All work shall conform to the American Institute of Steel Construction specifications for design, erection and fabrication, and acceptable standards of good practice. Finished members shall be true to line and free from twists and bends.
 - 3. Conform to ASTM Standard F2048- Guide for Fencing/ Barriers for Playgrounds.
 - 4. SSPC "Steel Structures Painting Manual, Volume 2, Systems and Specifications".
 - 5. Industrial Fasteners Institute "Fastener Standards Book".
 - 6. California Code of Regulations, Title 24, 2013 Edition, also known as California Building Code (CBC).
- B. Do not scale drawings for dimensions.
 - 1. Use only the written dimensions indicated on the Drawings, unless such be found in error.
 - 2. Contractor shall verify and be responsible for dimensions and conditions shown by the Drawings, and shall visit the site to inspect and verify field conditions prior to fabrication and installation.
 - 3. The Owner's Representative shall be notified, in writing, of discrepancies on Drawings, in field dimensions or conditions, and of changes required in construction details.
 - 4. Provide each type of gate as a complete unit produced by a single manufacturer, including required mounting accessories, fittings and fastenings.
 - 5. Details shown in the Drawings shall be followed for exterior appearance. Minor changes in interior construction will be accepted in order to conform to Contractor's shop practices or engineering requirements when, in the Owner's Representative's sole judgment, such changes do not detract materially from design concept or intent. Contractor shall circle such changes on the shop drawings.
 - 6. Completed work shall be structurally sound, and free from distortions, chips, breaks, holes, splits or other disfigurements considered as imperfections for the specific material.
- C. Completed work shall be structurally sound, and free from distortions, chips, breaks, holes, splits or other disfigurements considered as imperfections for the specific material.
- D. "Code of Arc and Gas Welding in Building Construction" of American Welding Society, WS D1.0, latest edition with current supplements and addenda, is hereby made a part of this Section and gate fabrication shall conform to the applicable requirements therein, except as otherwise specified herein or shown on the drawings. Nothing contained herein shall be construed as permitting work that is contrary to code requirements or governing rules and regulations.

E. All work shall conform to the American Institute of Steel Construction specifications for design, erection and fabrication, and acceptable standards of good practice. Finished members shall be true to line and free from twists and bends.

F.

1.3 STRUCTURAL DESIGN AND ENGINEERING

- A. Details in the Drawings indicate a general design approach for the gates but do not necessarily include the specific fabrication details required for the complete structural integrity of the gates, nor do they necessarily consider preferred shop practices of individual contractors. Such specific fabrication details shall be provided by the Contractor, who shall ensure that gates withstand any and static, dynamic and/or erection loads that act upon them, including such loads associated with handling and servicing.
- B. Contractor shall furnish a complete structural design for gates, incorporating reasonable safety factors necessary to protect the Owner and Contractor against public liability.
1. Such structural designs shall meet applicable local, state, and national codes, as well as testing laboratory listings, where required.
- C. Contractor shall be responsible for the engineering and internal construction of gates, and shall submit shop drawings and details for review by the Owner's Representative. Shop drawings for Gate Types shall be designed and stamped by a licensed Engineer currently registered in the State of California. Said stamped shop drawings shall specify structural components, including footings, and methods required to withstand the design loads associated with handling and servicing.
1. Structural design shall meet applicable local, state, and national codes, as well as testing laboratory listings, where required.

1.4 SUBMITTALS

- A. Product Data: If requested by Owner's Representative, submit manufacturers' catalog sheets, brochures, diagrams, schedules, charts, illustrations, test results and/or other standard descriptive data.
1. Mark up each copy to identify pertinent materials, products or models.
 2. Show dimensions and clearances required.
- B. Shop Drawings:
1. Shop drawings shall be neat, well organized and clearly legible. Elevations and plan views from the Drawings may be reproduced for the sake of expedience where appropriate.
 2. Shop drawings shall be drawn to scale and not subsequently reduced to fit a drawing format.
 3. Submit elevations and plan views for gate types, including graphic layouts, complete dimensions, materials, locations of fasteners and finishes. Determine the total quantity for each gate type and note it in the shop drawings.
 4. Submit comprehensive section drawings for gate types where applicable, including sections of typical members. Show fabrication and installation details, including details for securing members to one another, to structures, and/or to site work. Show interior construction, reinforcements, anchorages, components and finishes. Reproduction of section drawings shown in the Drawings shall not be acceptable.
 5. Site Condition Verification: Where required by the Owner's Representative for specific items, Contractor shall inspect site to confirm installation conditions, then submit shop drawings and/or written documentation for approval indicating proposed mounting devices.
- C. Samples:
1. Color and Finish: Submit 1 each samples of finish and colors. Prior to submittal, Contractor shall verify that colors submitted as samples match accurately any samples or specifications provided by Owner's Representative
 2. Prior to submittal, Contractor shall verify that colors submitted as samples match accurately any samples or specifications provided by Owner's Representative.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless steel:
 - 1. General:
 - a. For manufactured catalog items provide the Grade recommended by manufacturer for type of use and finish indicated, and with not less than the grade designated below for each stainless steel form required
 - b. Stainless Steel Finish: AISI 304 Stain, unless otherwise noted.
 - 2. Tubing: ASTM A554, Grade MT 316.
 - 3. Pipe: ASTM A312 Grade TP 316.
 - 4. Sheet, Strip, Plate, and Flat Bar: ASTM A666, Type 316.
 - 5. Bars and Shapes: ASTM A276, Type 316.
- B. Steel Tubing: ASTM A500 (cold-formed), Grade A or B, welded or seamless.
- C. Steel Pipe: ASTM 53, Type E or S, unless otherwise noted.
- D. Miscellaneous Steel Plates and Structural Steel Shapes: conforming to ASTM A36.
- E. Bolts: Structural grade steel, ASTM A307, with suitable hex nuts and washers, all stainless steel.
- F. Stain: Wood: see drawings.
- G. Welding Electrodes: As permitted by AWS Code D1.0.
- H. Fasteners, Hardware and Devices: Stock proprietary fastening devices of approved standard manufacture such as cadmium plated screws, bolts and washers, and stainless steel hinges.
 - 1. Conceal fasteners except where noted or shown otherwise.
 - 2. Finish on exposed devices to match overall gate finish, unless otherwise noted.
 - 3. Provide vandal-resistant fasteners at exposed locations unless otherwise noted.
 - 4. Use fasteners fabricated from metals that are non-corrosive to either the gate material(s) or the mounting surface.
- I. Hot Phosphate Treatment: conforming to SSPC-PT-4.

2.2 GATE ACCESSORIES AND HARDWARE

- A. General: Gates that are part of the accessible path of travel shall comply with Section 11B.404 Doors, doorways and gates of the California Building Code.
- B. Panic Hardware and Levers: Exit gates, excluding double swing gates not in path of travel, in the fence shall include lever or panic hardware to comply with Section 11B-404.2.7 Door and Gate Hardware of the California Building Code. Hardware shall be heavy duty, weather resistant type designed for outdoor use.

2.3 FABRICATION

- A. Intent of Specifications: Finished work shall be of the highest quality in order to pass eye-level examination and scrutiny by Owner's Representative.
 - 1. Work shall be free from burrs, dents, raw edges and sharp corners.
 - 2. Finish welds on exposed surfaces as required so they are not visible in the finished Work.
 - 3. Finish surfaces smooth unless otherwise indicated or specified.
 - 4. Surfaces which are intended to be flat shall be free from bulges, gaps or other physical deformities. Such surfaces shall be fabricated to remain flat under installed conditions.
 - 5. Surfaces which are intended to be curved shall be smoothly free-flowing to the required shape(s).
 - 6. Edges shall be true, and corners shall be square.
 - 7. Isolate dissimilar materials. Exercise particular care to isolate nonferrous metals from ferrous metals as required to prevent corrosion.

- B. Provide colors and/or finish textures as specified or indicated in the Drawings or, where not specified or indicated, as selected by Owner's Representative.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall inspect installation locations for conditions that will adversely affect the execution, permanence and/or quality of the Work, and notify Owner's Representative in writing of any and unsatisfactory conditions. Contractor shall not proceed with installation until said unsatisfactory conditions have been corrected. Commencement of installation indicates acceptance of site conditions and guarantees delivery of an acceptable product.

3.2 INSTALLATION

- A. Provide reinforced concrete footings with dimensions as specified by Engineer. Use Sonotube-type formwork for post gates.
- B. Where a concrete footing is flush with finished grade, slope the top of the footing away from the gate posts minimally as required for drainage and to prevent puddling.
- C. Securely attach gates to footings or site work in accordance with Engineer's specifications.
- D. Field Paint wood as specified.

3.3 SITE CLEANUP

- A. Final cleanup:
 - 1. Clean and/or repair evidence of installation work or damage to site work or other adjacent surfaces.
 - 2. Remove excess materials and dispose of properly off site.

3.4 CONTRACT CLOSE-OUT ITEMS

- A. Provide Owner's Representative with one quart of paint for each paint color specified.

END OF SECTION

**SECTION 323113
CHAIN LINK FENCING**



New Section, August 26, 2016

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete Design-build services for chain link fencing and rolling gates, posts, hardware and electrical operators, post holes and concrete footings as shown on the drawings and as specified.
- B. Related requirement specifications elsewhere:
 - 1. Section 31 00 00, EARTHWORK
 - 2. Section 033000 – Cast-In-Place Concrete
 - 3. Division 26 Electrical – Electrical Work In Connection With Motor Operated Gates.
 - 4. Section 321313, SITE CONCRETE (CONCRETE PAVING)

1.2 QUALITY ASSURANCE

- A. Reference Standards
 - 1. State of California Department of Transportation (Caltrans), "Standard Specifications."
 - 2. Manufacturer's recommendations and specifications.
 - 3. ASTM A36 Standard Specification for Carbon Structural Steel
 - 4. ASTM A392 Standard Specification for Zinc-Coated Steel Chain-Link Fabric
 - 5. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-dip Galvanized Coatings
 - 6. ASTM A817 Standard Specification for Metallic-Coated Steel Wire for Chain Link Fence Fabric and Marcellled Tension Wire
 - 7. ASTM A824 Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link
 - 8. ASTM F552 Standard Terminology Relating to Chain Link Fencing
 - 9. ASTM F567 Standard Practice for Installation of Chain Link Fence
 - 10. ASTM F626 Standard Specification for Fence Fittings
 - 11. ASTM F668 Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain Link Fence Fabric
 - 12. ASTM F900 Standard Specification for Industrial and Commercial Swing Gates
 - 13. ASTM F1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework
 - 14. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
 - 15. ASTM F1664 Standard Specification for Polyvinyl Chloride (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used With Chain Link Fence
 - 16. WLG2445 Chain Link Fence Manufacturers Institute, Chain Link Fence Wind Load Guide for the Selection of Line Posts and Line Post Spacing
 - 17. Local City or County Codes, whichever is more stringent.

1.3 SUBMITTALS

- A. Shop drawings: Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations. Layout of gate operator and entry/exit equipment.
- B. Product data: Manufacturer's catalog cuts indicating material compliance and specified options.
- C. Submit sample of each fabric size and manufacturers standard color chart or samples.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Company having manufacturing facilities in the United States with 5 years experience specializing in manufacturing of chain link fence products.
- B. Fence contractor: Contractor having 5 years experience installing similar projects in accordance with ASTM F567.
- C. Single source: To ensure system integrity obtain the chain link system, framework, fabric, fittings, gates and accessories from a single source.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and/or Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
- B. Failures include, but are not limited to, deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- 1. Anchor Fence/Master Halco Inc., Baltimore MD (800) 229-5615 (specified); Boundary Fence & Railing Systems, Richmond Hill, NY (800) 628-8928; Builders Fence Company, Sacramento, CA (916) 381-4065; or Approved Equal.
- 2. Gate operator and entry/exit equipment as recommended or supplied by fencing and gate manufacture, or as recommended by design build contractor as appropriate for design layout shown in construction documents.
- 3. Manufacturer: Company shall have manufacturing facilities in the United States with a minimum 5 years experience specializing in manufacturing of chain link fence products.

2.2 FENCE SYSTEMS

- A. CHAIN LINK FENCE: Round Schedule 40 vinyl coated galvanized steel frame with concrete post footings, round rail at top and **at bottom**, and 9-gauge, 1-3/4" mesh, vinyl coated galvanized chain link fabric. All rods, bars, bands, clips, bolts, tension wire, and other fittings shall be vinyl coated.

2.3 MATERIALS

- A. Conform to Caltrans Standard Specifications, Section 80, except as required otherwise herein:
 - 1. Fabric: Hot-dipped galvanized after weaving, conforming to ASTM A116-88. Tensile strength of fabric shall be 80,000 psi minimum. Fabric shall be knuckled top and bottom, single width fabric to full height of fence. 9-gauge wire size plus vinyl fused-bonded color coating. Vinyl bonded fabric shall be fused-bonded with a PVC coating of 7 to 12 MILS (.007" to .012") per ASTM- F668 Class 2B.
 - 2. Color of chain link fabric per ASTM F934 as shown on Drawings.
 - 3. Tight fitting wood slatting to match adjacent wood fencing species and finish. See landscape plans for extent and orientation of wood slatting.
 - 4. Wood cladding to match adjacent wood fencing species and finish. See landscape plans for extent and orientation of wood slatting.
 - 5. Steel pipe: All fence frame posts, rails, braces, shall be round pipe ASTM F1043 Group IA, ASTM F1083 standard weight schedule 40 hot-dip galvanized pipe having a zinc coating of 1.8 oz/ft² (550 g/m²) on the outside and 1.8 oz/ft² (550 g/m²) on the inside surface.
 - 6. Exterior of galvanized pipe to have F1043 PVC thermally fused color coating, minimum thickness 10 mils (0.254 mm).

7. All fittings to be PVC thermally fused color coated having a minimum thickness of 0.006" (0.152 mm) per ASTM F626. PVC color to match fabric and framework. Moveable parts, nuts and bolts to be field coated with PVC liquid touch up after installation.
8. Truss rod assembly: Fused-bonded vinyl finish galvanized steel minimum 5/16" diameter truss rod with pressed steel tightener, in accordance with ASTM F626
9. Post caps: ASTM F626 galvanized pressed steel, malleable iron, or aluminum alloy weather tight closure cap for tubular posts with fused-bonded vinyl finish. Provide one cap for each post. When top rail is specified provide line post loop tops to secure top rail.
10. Tension wire: Poly Vinyl Chloride (PVC) coated metallic coated steel tension wire per ASTM F 1664, 7 gauge steel core wire, 0.177", PVC coating class and color to match chain link fabric
11. Rail ends: Galvanized pressed steel per ASTM F626, for connection of rails to post using a brace band.
12. Top rail sleeves: 7" (178 mm) galvanized steel sleeve per ASTM F626. If expansion and contraction of the rail is of concern add a 0.137" wire diameter by 1.80" long expansion spring between the adjoining rails]
13. Wire ties: 9 gauge (0.148") galvanized steel wire for attachment of fabric to line posts and rails. Pre-formed hog ring ties to be 9 gauge (0.148") galvanized steel or aluminum for attachment of fabric to tension wire. Tie wire and hog rings PVC coated and in compliance with ASTM F626. Color to match fabric color.
14. Concrete: Minimum 28 day compressive strength of 3,000 psi.

B. Fence Post Schedule:

FENCE HEIGHT	END & CORNER POSTS		LINE POSTS			
	POST SIZE (O.D.)	FOOTING DEPTH & DIA.	POST SIZE (O.D.)	FOOTING DEPTH & DIA.	HORIZONTAL RAIL (O.D.)	MAXIMUM POST SPACING
42"	2 1/2" 3.65 lb/ft	10" dia. 24" deep	2" 2.72 lb/ft	10" dia. 24" deep	1 5/8" 2.27 lb/ft	8'-0" o.c.
4'	2 1/2" 3.65 lb/ft	10" dia. 24" deep	2" 2.72 lb/ft	10" dia. 24" deep	1 5/8" 2.27 lb/ft	8'-0" o.c.
6'	2 1/2" 3.65 lb/ft	10" dia. 30" deep	2" 2.72 lb/ft	10" dia. 30" deep	1 5/8" 2.27 lb/ft	10'-0" o.c.
7'	3" 5.79 lb/ft	12" dia. 36" deep	2 1/2" 3.65 lb/ft	12" dia. 36" deep	1 5/8" 2.27 lb/ft	8'-0" o.c. and 10'-0" o.c.
8'	3" 5.79 lb/ft	12" dia. 36" deep	2 1/2" 3.65 lb/ft	12" dia. 36" deep	1 5/8" 2.27 lb/ft	8'-0" o.c. and 10'-0" o.c.
10'	3" 5.79 lb/ft	12" dia. 40" deep	3" 5.79 lb/ft	12" dia. 40" deep	1 5/8" 2.27 lb/ft 1 ctr. rail	8'-0" o.c.
12'	3" 5.79 lb/ft	15" dia. 48" deep	3" 5.79 lb/ft	15" dia. 48" deep	1 5/8" 2.27 lb/ft 1 ctr. rail	8'-0" o.c.
20'	4" 9.11 lb/ft	18" dia. 60" deep	4" 9.11 lb/ft	18" dia. 60" deep	1 5/8" 2.27 lb/ft 2 ctr. rail	8'-0" o.c.

- C. Above post footing sizes indicate a post bury to a minus 4 inches from bottom of footing. Where center rails are required, provide braces and trusts top and bottom panels.
- D. Gate Post Schedule (7' maximum height gates):

Gate Opening	Gate Post Size	Gate Post Footing Size
to 6' wide	3" o.d.(5.79 lb/ft)	12" dia. x 36" deep
>6' to 12' wide	4" o.d.(9.11 lb/ft)	12" dia. x 48" deep
>12' to 18' wide	6-5/8" o.d.(18.97 lb/ft).	18" dia. x 54" deep
over 18' wide	8-5/8" o.d.(28.55 lb/ft).	*(confirm)

2.4 CHAIN LINK ROLLING GATE

- A. Gate frames: Fabricate chain link cantilever slide gate in accordance with ASTM F 1184, Type II, Class 2, using 50 mm (2-inch) square aluminum members, ASTM B 221, alloy and temper 6063-T6, weighing 1.4 Kgs/M (0.94 lb/ft). Weld members together forming rigid one-piece frame integral with top track. Provide 2 truck assemblies for each gate leaf.
- B. Gate Fabric assembly: Install fabric with hook bolts and tension bars at all 4 sides. Attach to gate frame at not more than 375 mm (15 inches) on center.
- C. Bracing: Provide diagonal adjustable length truss rods of 9 mm (3/8") galvanized steel, in each panel of gate frames
- D. Track/rail: Enclosed combination one-piece track and rail, aluminum extrusion with weight of 6 mm (3.72 lb/ft). Track to withstand reaction load of 900 Kg (2,000#).
- E. Truck assembly: Swivel type, zinc die cast, with 4 sealed lubricant ball bearing rollers, 50 mm (2 inches) in diameter by 14 mm (9/16") in width, and 2 side rolling wheels to ensure truck alignment in track. Mount trucks on post brackets using 22 mm (7/8") diameter ball bolts with 13 mm (1/2") shank. Truck assembly to withstand same reaction load as track, 970 Kg (2,000 #)
- F. Gate hangers, latches, brackets, guide assemblies, and stops: Malleable iron or steel, galvanized after fabrication. Provide positive latch with provisions for padlocking. These fittings do not receive PVC coating.
- G. Bottom guide wheel assemblies: Each assembly shall consist of two, 75 mm (3") diameter rubber wheels, straddling bottom horizontal gate rail, allowing adjustment to maintain gate frame plumb and in proper alignment. Attach one assembly to each guidepost. These fittings do not receive PVC coating.
- H. Gates posts: Galvanized steel 100 mm (4") OD Schedule 40 pipe, ASTM F 1083, weighing 14 Kgs/M (9.1 lb/ft). Provide 1 latch post and 2 support posts for single slide gate.
- I. Gate finish: all members, PVC Vinyl Coated (except track/ bottom guide wheel assemblies) 250 to 375 microns (10 to 15 mils) thick thermally fused, ASTM Class-2b, black color, or as approved during the submittal process.

PART 3 - EXECUTION

3.1 SITE EXAMINATION

- A. Ensure property lines and legal boundaries of work are clearly established.
- B. Survey of fence location to be provided by general contractor

- C. Verify areas to receive fencing are completed to final grade.
- 3.2 **FENCE FABRICATION AND ERECTION: Shall be in accordance with Caltrans Standard Specification Section 80, except as otherwise specified herein:**
- A. Post Installation: Set posts in undisturbed or compacted soil, evenly spaced, plumb and true to lines with top line uniform in concrete to depths herein specified. End, corner, pull and gate posts to be braced with same material as top rail and trussed to line posts with 3/8" rods and tighteners. Line posts shall be evenly spaced 10' or less as specified. Top rail shall pass through line post tops and form a continuous brace within each stretch and be securely fastened to terminal posts. Splices in top rail shall be made with couplings at approximately 20' spacing. Set each post in 3,000 psi concrete footing sized in accordance with above Fence Schedule.
- B. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
- C. Bracing: Install horizontal brace and truss assembly at mid-height or above for fences 6' and over at each fabric connection to the terminal post. The diagonal truss rod is installed at the point where the brace rail is attached to the terminal post and diagonally down to the bottom of the adjacent line post. Place the truss rod in tension by adjusting the turnbuckle
- D. Except as required otherwise, set top of concrete footing flush with grade and trowel smooth to slope away from post to drain. Post to extend to 4" from bottom of concrete footing. Allow concrete footings to cure 5 days before erection of fabric.
- E. Tension wire: Install tension wires so that it will be located 4" up from bottom the fabric. If top rail is not required, install the tension wire so that it will be located 4" down from the top of the fabric. Stretch and install tension wire before installing the chain link fabric and attach it to each post using wire ties.
- F. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces.
1. Remove all metal shavings from cut area.
 2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.
 3. Apply 2 coats of custom finish paint matching fence color if fence is painted.
- 3.3 **GATES:**
- A. Shall be structurally stable vertically and laterally, in any position.
- B. Gate openings shown on plans to be face-to-face dimension of gate posts. Swing or rolling path of gates to be as shown. Contractor shall verify grade conditions at bottom of gate and submit shop drawings that respond to field conditions.
- C. Install gates plumb, level, and secure for full opening without interference. Set keepers, stops and other accessories into concrete as required by the manufacturer and as shown. Adjust hardware for smooth operation and lubricate where necessary.
- D. Provide shop drawings indicating necessary rail sizes and trussing appropriate for gate opening.
- 3.4 **RAILS:**
- A. Make splices at top rails with couplings at approximately every 20'. Coupling shall produce a continuous brace of railing from end to end of each stretch of fence. Every fifth coupling in a stretch shall be fitted with a heavy spring to allow for expansion and contraction of rail. Rigidly clamp rails to end and corner post with appropriate fittings. Clamp mid-rail and bottom rail at each post using rail end or line rail clamps.. Stretch all fabric tight, free from sags and bulges.
- 3.5 **ACCESSORIES**
- A. Privacy cladding: Wood cladding to match adjacent wood fencing species and finish. See landscape plans for extent and orientation of wood slatting.

3.6 **CLEANING: Per Section 01 74 00.**

- A. Clean up area adjacent to fence line from debris and unused material created by fence installation. Remove any concrete splash from fence posts.

END OF SECTION

SECTION 323233 STONE WALLS



New Section, August 26, 2016

PART 1 GENERAL

1.1 SUMMARY

- A. This specification is a "performance" section, thereby outlining the results but leaves the design, means and methods to be determined by the Contractor.
- B. The section includes but is not limited to furnishing materials, labor and permits to provide the following work:
 - 1. The Engineering Calculations and Certification, and submission of the "signed" engineering wall documents. The Engineer certifying the wall calculations is referred to in this specification section as the: "Wall Designer".
 - 2. Provide all earthwork and Geogrid reinforcement within the "Wall Limits" as defined in these specifications and the plan documents.
 - 3. Furnish and erect stone retaining walls and benches as defined in the bid documents.
- C. Related Sections:
 - 1. Section 031000 - Earthwork: Coordinate the work. Avoid duplications and/or omissions.
 - 2. Section 321540 - Exterior Stone Surfacing and Features: Coordinate with the boulder walls, stone surfacing and pavers in this specification.

1.2 REFERENCES

- A. Concrete Units - American Society for Testing and Materials (ASTM) www.astm.org
 - 1. ASTM C-1372 Specification for Segmental Retaining Wall Units
 - 2. ASTM C 1262 Freeze-Thaw Durability of Concrete Masonry Units
 - 2. ASTM D-422 Particle Size Analysis
 - 3. ASTM D-698 Laboratory Compaction Characteristics of Soil -Standard Effort
 - 4. ASTM D-4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils
- B. Drainpipe
 - 1. ASTM D-3034 Specifications for Polyvinyl Chloride Pipe (PVC)
 - 2. ASTM D-1248 Specifications for Corrugated Plastic Pipe
- B. Geogrid Reinforcements - Geosynthetic Research Institute (GRI)
 - 1. GG1-87 Test Method for Geogrid Rib Tensile Strength
 - 2. GG2-87 Test Method for Geogrid Junction Strength
 - 3. GG3-91 Test Method for Tension Creep of Geogrids
 - 4. GG4-91 Determination of Long Tern Design Strength of Geogrids
 - 5. GG5-91 Determination of Geogrid (soil) Pullout
 - 6. ASTM D-4595 Tensile Properties of Geotextiles - Wide Width Strip
 - 7. ASTM D-5262 Unconfined Tension Creep Behavior of Geosynthetics
- C. Engineering Design - National Concrete Masonry Association (NCMA)
 - 1. NCMA - Design Manual for Segmental Retaining Walls
 - 2. NCMA SRWU-1 Test Method for Determining Connection Strength of SRW
 - 3. NCMA SRWU-2 Test Method for Determining Shear Strength of SRW
- D. Soils
 - 1. ASTM D-698 Laboratory Compaction Characteristics of Soil -Standard Effort

2. ASTM D-4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils
3. ASTM D-422 Gradation of Soils
4. ASTM D-424 Atterberg Limits of Soils
5. ASTM D-G51 Soil pH

1.3 DEFINITIONS

- A. The plans and this specification section identifies three types of stone walls:
 1. Stone Wall Type 2: These are typically small freestanding or small retaining walls retaining a few feet of earth. Using multiple smaller blocks that are mortared.
- B. The drawings identify stone dimensions as follows:
 1. Length: The dimension running parallel to the face.
 2. Depth: The dimension running perpendicular to the face.
 3. Thickness: The vertical dimension on each stone layer.

1.4 SUBMITTALS

- A. Submit samples of each stone specified to the Architect for color and finish approval. Manufacturer's and or installer's data showing tolerances and variances for stone sizes, texture color, etc.
- B. "Wall designer" to submit details and signed construction documents by a Licensed Engineer in the State of California that designs stone retaining walls. Submit these documents to the Architect's office for information only, not as shop drawings. Calculations should not be submitted, however, the plans must identify the design assumptions, type of stone, mortar, backfill, spacing between the geogrid layers and similar design elements proposed to be used.
- C. Drawings of the stone walls and benches including plan view, sections, and elevations. Retaining wall design and details must include geogrid reinforcement and drainage provisions. Show or indicate how the top units will be secured.
 1. The Architect's AutoCAD drawings may be available for use as a background for the wall designer.
 2. Lateral reinforcement shall be used on all walls retaining more than 3 feet, unless the wall designer certifies them as gravity retaining walls.
- D. All submittals are required at the Architect's office at least six weeks before scheduled start of the retaining wall system.
- E. The design shall be by a Professional Engineer Registered in California. The engineering design will be per NCMA Design Guidelines for Segmental Retaining Walls. The Architect's office Review of the signed wall documents by the Owner and Architect's office shall not transfer any of the design responsibility away from the wall designer, supplier and installer.

1.5 QUALITY ASSURANCE

- A. The "wall designer" provides calculations and certifies the wall design. The wall designer must have designed at least twelve successful wall projects of similar size.
- B. The "wall installer" must have at least twenty successful wall projects of similar size. At any time during wall construction the installer must have a superintendent in the field with at least eight successful wall projects of similar size
- C. Provide the appropriate equipment, materials and labor for the project.
- D. Completed walls must have a slight batter leaning back. Some natural variations in color may be allowed provided it is blended throughout the wall and is similar to the "sample walls". The wall must also have a tolerance in the face blocks of +/- 1/2 inch, with gaps between blocks small enough to prevent soil from passing through.

1.6 MOCK-UPS

- A. Construct a sample of the applicable wall type. The wall may be placed at proposed wall and bench locations; however, it is the Contractors risk that the items will be accepted. If not accepted, they must be removed and another sample constructed. Assume the review and acceptance of the sample walls will take at least 2 weeks after the completion of the samples. This will allow adequate time for the Owner's Representatives and Architect's office to review the quality of the workmanship and appearance. These "field samples" will provide the acceptable tolerances in workmanship, color variations and general appearance that the remainder of the wall shall match.

PART 2 PRODUCTS

2.1 STONE WALL MATERIALS

- A. The following paragraphs under article 2.1 apply to all the stone walls.
- B. Wall Stone: May be from the following suppliers for a non-grouted block wall: Keystone Hardscapes, Minneapolis, MN (800) 747-8971; Baselite Concrete Products, Dixon, CA, (8077) 235-4273.
- C. Setback: Batter to be determined by the designer. Minor batter is preferred.
- D. Geogrid: shall be high-density polyethylene or polyester material as manufactured by Mirafi or Tensar Incorporated or equal. The wall documents submitted must identify the geogrid, type, depth and layering dimensions for each wall, as needed.
- E. Detail 3 on drawing **L402** identifies "Wall limits". All earthwork and construction within the active earth zone of these walls is to be completed by this specification section.
- F. Wall Backfill: Must be per Caltrans standard specification for a class 2 gradation aggregate base. Compact this granular fill as required by the wall designer of the design calculations and wall backfill criteria in earthwork specification 02200. All the backfill within the "wall zone" defined in the documents typical cross section must be imported to the site.
- G. Drainage Aggregate: As determined by the "wall designer". Use around the drainpipe behind walls. Provide fill consisting of free-draining, coarse aggregate that is 1/2" to 3/4" with no more than 5% passing the No. 50 sieve and conforming to requirements of ASTM D448-86 Standard Classification for Sizes of Aggregate for Road and Bridge Construction, designation 5, 7, 6, 7 or 8. The "wall designer" will determine the exact gradation of the fill. Do not provide "Pea gravel".
- H. Drainpipe: As determined by the "wall designer". Provide a backfill drainpipe of a diameter specified by the system designer. A four-inch diameter perforated pipe may be used if a larger diameter is not required by the system designer.

2.2 STONE WALL TYPE 2

- A. Natural top/bottom split all sides.
- B. The drawings identify stone dimensions as follows:
 - 1. Length: Manufacturer's standard lengths of appropriate product for wall height, determined by wall designer and submitted to architect for review and approval.
 - 2. Depth: Manufacturer's standard depth and height of appropriate product for wall height, determined by wall designer and submitted to architect for review and approval.

2.3 AGGREGATE BASE

- A. Aggregate Base: Conform to Caltrans standard, 3/4" minus gradation (formerly gradation 2), crushed gravel.

2.4 SETTING BED

- A. Setting Bed: Concrete Sand or as recommended by stone manufacturer.

2.5 DESIGN REQUIREMENTS

- A. Design of the retaining wall based on the soil boring report and intended imports.
- B. Retaining walls shall be designed to resist lateral pressures associated with compacted backfill as well as any surcharge pressures from foundations, pavements and live loads and railings.
- C. Hydrostatic pressures can add considerable lateral load; therefore, drainage shall be considered in retaining wall design.

PART 3 EXECUTION

3.1 TRENCH PREPARATION

- A. Excavate a shallow trench to the depth and width of the modules, plus allowance for granular fill material. Place a 6" layer (deeper if shown on the drawings), of granular fill and compacted by the Ordinary Compaction Method. The base material is to be placed on undisturbed native soils or suitable replacement fills compacted to 95% minimum of Standard Proctor. Place and compact a "leveling pad" as detailed. Upper layers of series walls may be placed directly on the backfill of the lower walls as determined by the "wall designer".

3.2 INSTALLATION – ALL WALLS

- A. Top of Walls: Unless noted otherwise, top of walls are typically level, +/-1 inch, with no obvious dips or areas of settlement. The installer must contact the Architect's office of any concerns related to this design intent, if necessary, walls could step, but must be submitted in shop drawings and approved prior to installation.
- B. Stagger joints: All walls must be assembled in a pleasing pattern with staggered joints as appropriate to chosen stone sizes.
- C. The grade on the high side of the wall to be 1/10 foot below the top of wall to reduce soil staining the walls.

3.3 INSTALLATION – STONE WALL TYPE 2

- A. Prepare an 12" thick aggregate base compacting each 6" lift to 95% standard proctor density and have the Geotechnical Representative verify suitability as a base and soil densities. Place and tamp aggregate base, 1" thickness of concrete sand may be used to level the sub-base. Place subsequent courses using associated hardware per manufacturer's interlocking system.

END OF SECTION

SECTION 328400 IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Layout and installation of an irrigation system to provide full coverage of all plant material. System includes new water meter, controller, master valve, flow sensor, control valves, wiring, quick couplers, low volume micro sprays, and drip irrigation.

1.2 CALIFORNIA MODEL WATER EFFICIENT LANDSCAPE ORDINANCE REQUIREMENTS

- A. Contractor shall be familiar with and follow the State of California Model Water Ordinance, California Code of Regulations, Title 23 Waters, Division 2, Department of Water Resources, Chapter 2.7. Also, the Contractor is responsible to follow all local water ordinances.
- B. Pursuant to the requirements of the California Model Water Efficient Landscape Ordinance, the Contractor shall submit a Certification of Installation to the Local Jurisdiction /water purveyor as described in the construction documents and these specifications. Certification shall at a minimum include the following documents:

PART 1. Project Information Sheet

PART 2. Certification of Installation according to the landscape documentation package.

PART 3. Irrigation Scheduling and Controller Programming

PART 4. Schedule of Landscape and Irrigation

PART 5. Landscape Irrigation Audit Report

PART 6. Soil Management/Analysis Report with verifying implementation, see Planting Specification for analysis requirements.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Specifications: Follow manufacturer's current printed specifications and drawings in all cases where the manufacturers of articles used in the Contract furnish directions covering points not specified or shown in the drawings.
- B. Ordinances and Regulations: All local, municipal and state laws, codes and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship or construction of a better quality, higher standard, or larger size than is required by the above codes and regulations, the provisions of these Specifications and Drawings shall take precedence. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.
- C. References, Codes and Standards:
 - 1. AB 325 and 1881 State of California Model Water Efficient Landscape Ordinance, California Code of Regulations Title 23.
 - 2. California Environmental Quality Act (CEQA)
 - 3. Water Use Classification of Landscape Species (WUCOLS).
 - 4. American Society of Irrigation Consultants (ASIC) Design Guidelines.
 - 5. California Landscape Standards, California Landscape Contractors Association, (CLCA) Sacramento, California.
 - 6. CAL-OSHA, title 8, Subchapter 4-Construction Safety Orders and Subchapter 7-General Industry Safety Orders.
 - 7. California Electric Code.
 - 8. California Plumbing Code (UPC) published by the Association of Western Plumbing Officials.
 - 9. NFPA 24, Section 10.4, Depth of Cover.

10. Underwriters Laboratories (UL): Electrical wiring, controls, motors and devices, UL listed and so labeled.
 11. American Society of Testing Materials (ASTM).
- D. Furnish without extra charge any additional material and labor when required by the compliance with all above mentioned codes and regulations, though the work be not mentioned in these specifications or shown on the drawings.
 - E. All work in this section shall be coordinated with Civil and Plumbing documents
 - F. Experience: Assign a full-time employee to the job as supervisor for the duration of the Contract with a certified landscape technician, irrigation certification through CLCA or minimum of four (4) years experience in landscape irrigation installation.
 - G. Labor Force: Provide a landscape installation and maintenance force thoroughly familiar with, and trained in, the work to be accomplished to perform the task in a competent, efficient manner acceptable to the Owner's Representative.
 - H. Explanation of Drawings:
 1. Due to the scale of the Drawings, it is not possible to indicate all piping offsets, fittings, sleeves, etc., which may be required. Carefully investigate the conditions affected all of the work and plan accordingly, and furnish all required fittings. Install system in such a manner to avoid conflicts with planting, utilities and architectural features.
 2. Do not install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in arc dimensions exist that might not have been considered in engineering. Bring such obstruction or differences to the attention of the Owner's Representative. Notify and coordinate irrigation Work with applicable contractors for location and installation of piping and sleeves through or under walls, pavement and structures. In the event this notification is not given, the Contractor shall assume full responsibility for any revision necessary.
 - I. Trench Interference with Tree Root Systems:
 1. Prior to trenching, layout main and lateral line locations within Drip Line of trees and review locations with Owner's Representative. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Owner's Representative.
 2. Mechanical Trenching is not allowed within dripline of existing trees to be protected except as approved by Owner's Representative.
 - J. Coordinate plant locations with emitter locations.
 1. Adjust plant locations in relation to the subsurface emitter s as required to ensure that the plant roots receive the proper amount of water in order for it to thrive.
 2. Coordinate planting and irrigation and provide hand watering of emitter irrigated and drip irrigated areas as required to maintain moist root zones until end of plant establishment period.

1.4 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

- A. The Drawings show, if applicable, existing above and below grade structures and utilities that are known to the Owner's Representative. Locate known existing installations before proceeding with construction operations that may cause damage to such installations. Existing installations shall be kept in service where possible and damage to them shall be repaired with no adjustment of Contract Sum. Verify with Owner's Representative if As Built drawings are available.
- B. If other structures or utilities are encountered, request Owner's Representative to provide direction on how to proceed with the Work. If a structure or utility is damaged, take appropriate action to ensure the safety of persons and property.
- C. Verify location of existing irrigation systems to be removed and/or replaced. Maintain any existing systems as required by the Drawings and Specifications, including temporary retention of systems necessary to maintain existing on site and adjacent planting.

1.5 SUBMITTALS

A. Materials List:

1. Submit required copies of the cut sheets and a complete list of materials proposed for installation, along with any proposed substitutions clearly identified and obtain the Owner Representative's written approval thereof before proceeding. Use only accepted materials and items of equipment.
2. List all materials by manufacturer's name and model number.
3. Submit to Local Water Purveyor with copy to the Owner's Representative Certification of Installation as required by the State of California Model Water Ordinance.

B. Substitutions:

1. If the Contractor desires to substitute a product, he shall list each item and note it as a "substitution" and provide the following information:
 - a. Descriptive information describing its similarities to the specified product.
2. If the product is approved and, in the opinion of the Owner's Representative, the substituted product does not perform as well as the specified product, the Contractor shall replace it with the specified product at no additional cost to the Owner's Representative.

C. Operations and Maintenance Manuals:

1. Prior to the final acceptance of the irrigation system, furnish three (3) individually bound Operation and Maintenance Manuals to the Owner's Representative for use by the Owner's Representative. The manuals shall contain complete enlarged drawings, diagrams and spare parts lists of all equipment installed showing manufacturer's name and address. In addition, each Service Manual shall contain the following:
 - a. Index sheet indicating the Contractor's name, address and phone number.
 - b. Copy of the Landscape Irrigation Audit
 - c. Copy of the 12-month irrigation schedule and estimate of annual water consumption
 - d. Copies of equipment warranties and certificates.
 - e. List of equipment with names, addresses and telephone numbers of all local manufacturer representatives.
 - f. Complete operating and maintenance instructions in sufficient detail to permit operating personnel to understand, operate and maintain all equipment.
 - g. Parts list of all equipment such as controllers, valves, solenoids and heads.

D. Record Drawings:

1. Dimension the location of the following items from two (2) permanent points of reference such as building corners, sidewalks, road intersections, etc.:
 - a. Connection to existing water lines/meter.
 - b. Connection to electrical power.
 - c. Gate valves.
 - d. Routing of sprinkler pressure lines (a dimension at least every 100 feet and as required to identify all changes in direction and location).
 - e. Remote control valves.
 - f. Routing of control valves.
 - g. Quick coupling valves.
 - h. All sleeve locations.
 - i. Routing of all control wiring.
 - j. Include all invert elevations below 12".
2. Deliver a reproducible record drawing to the Architect within seven (7) working days before the date of final review. Delivery of the record drawings shall not relieve the Contractor of the responsibility of furnishing required information in the future.

E. Controller Plan:

1. Provide one Irrigation Diagram plan in each controller housing. The plan shall show the area controlled by each valve in different colors and for orientation, any major permanent structure such as buildings and roads.

2. Charts to be waterproof and hermetically sealed between two pieces of transparent 10 mil thick plastic and installed in each controller on the door as accepted by the Owner's Representative no later than the time of the coverage test of the irrigation system.
- F. Maintenance Material - supply the following tools to the Owner's Representative:
1. Three (3) sets of specialized tools required for removing, disassembling and adjusting each type of sprinkler, valve or other equipment supplied on this project.
 2. Two (2) keys for each type of equipment enclosure.
 3. Two (2) keys for each type of automatic controller.
 4. Two (2) keys for each type of valve (including square type key for valves larger than 2")
 5. Two (2) quick-coupler keys and matching hose swivels for each type of quick-coupling valve installed.
 6. All lock keys shall be keyed alike.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Furnish and deliver materials in manufacturer's packaging, bearing original legible labeling.
- B. The Contractor is cautioned to exercise care in handling, loading, unloading, and storing PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of the pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented, cracked, or otherwise damaged shall be discarded and, if installed, shall be replaced with new piping.

1.7 TRENCH INTERFERENCE WITH TREE ROOT SYSTEMS:

- A. Prior to trenching, layout main and lateral line locations within Drip Line of trees and review locations with Owner's Representative. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Owner's Representative.

1.8 SEQUENCING AND SCHEDULING

- A. Acceptance: Do not install main line trenching prior to acceptance by Owner's Representative of rough grades completed under another Section.
- B. Coordination: Coordinate with the work of other sections to insure the following sequence of events:
 1. Sleeves and Conduits: Installation of all sleeves and conduits to be located under paving and through walls prior to placement of those materials.
 2. Bubbler Heads: Install after placement of tree, but prior to backfill with planter soil mix.
 3. On-Structure Equipment: Install piping and risers after waterproofing is accepted.
 4. Sprinkler Head in Pots: Install riser and seal the penetration of the pot prior to backfill of pot with drainage materials and planter soil mix.
 5. Coordinate work schedule with Owner's Representative to avoid disruption of landscape maintenance of existing landscaping.
 6. Install piping prior to soil preparation (planting soil amendment installation).

1.9 WARRANTY

- A. In addition to manufacturer's guarantees and warranties, work shall be warranted for one (1) year from date of final acceptance against defects in material, equipment and workmanship. Warranty shall also cover repair of damage to any part of the premises resulting from leaks or other defects in materials, equipment and workmanship to the satisfaction of the Owner's Representative.

PART 2 - PRODUCTS

2.1 PIPE

- A. Pressure Main Line Pipe and Fittings: All PVC fittings shall bear the manufacturer's trademark name, material designation, size, applicable I.P.S. schedule and NSF seal of approval.

- B. All main line pipe shall be solvent welded and shall be schedule 40 unless shown otherwise on the Drawings.
1. PVC Pressure Rated Pipe: ASTM D2241 NSF approved Type I, Grade I, solvent welded PVC with an appropriate standard dimension ratio (S.D.R.).
 2. PVC Scheduled Pipe: ASTM D1785 NSF approved, Type I,
 3. Grade I, solvent welded PVC.
 4. PVC Solvent-weld Fittings: ASTM D2466 Schedule 40, 1-2, II-I NSF approved.
 5. Solvent Cement and Primer for PVC solvent-weld pipe and fittings: Type and installation methods prescribed by the manufacturer.
 6. Connections between Main Lines and RCVs: Schedule 80 PVC (threaded both ends) nipples and fittings unless required otherwise by local jurisdiction.
 7. Valves 2-inch and larger shall be flanged only.
 8. Copper pipe shall be Type K or Red Brass where threaded joints are required and Type L otherwise.
- C. All lateral line pipe shall be solvent welded and shall be schedule 40 unless shown otherwise on the Drawings.

2.2 CONTROLLER ENCLOSURES

- A. Type: Use one of the following or approved equal (unless noted otherwise on the Drawings):
1. Stainless steel, NEMA Type 3 rated, with back panel, padlocking hasp and padlock Rain Bird, Le Meur, "Strong Box" or approved equal. See Detail for pedestal construction.
 2. Rain Bird, "Non-Central" Controller Assemblies
 - a. LXMM – ESP – LXM Cabinet, Powder Coated Steel
 - b. LXMPED – ESP-LXM Pedestal, Powder Coated Steel
 3. Verify correct equipment to fit the specified equipment from Rain Bird Services Corporation "Package Systems" for "Central Control" projects. Available from Rain Bird Services Corporation (RBSC) (888) 444-5756.
 4. Le Meur, (714) 822-5100.
 5. "Strong Box" available from John Deere, (800) 347-4272.

2.3 REMOTE CONTROL VALVE: As shown on Drawings and with the following minimum requirements:

- A. Remote control valves shall be those normally manufactured for irrigation systems and shall have a slow, consistent speed of closure through entire closing operation, including last portion. To ensure this, the effective diaphragm working area/valve seating opening ratio must be a minimum 3 to 1.
- B. Shall be mechanically self-cleaning to help prevent diaphragm or solenoid port plugging. To ensure this, the flush rod should be tapered to vary the size of the port opening as the diaphragm raises and lowers, thus allowing trapped material to escape. Rod is to be finished with a serrated surface to help scrub trapped material out. Screens not acceptable.
- C. Shall have removable valve seat so valve can be repaired without removal from irrigation line.
- D. Shall have ability to operate manually without the use of wrenches or special keys.
- E. Shall have one-piece solenoid that attaches directly to valve without shunts or clips that can be lost.
- F. Shall have cross top handle to adjust maximum travel of diaphragm to allow "tuning" of valve and closure.

2.4 BOX FOR REMOTE CONTROL VALVE

- A. Rectangular black plastic valve box - Ametek, Carson, Christy, Rain Bird or approved equal with non-hinged bolt down black colored lid marked "irrigation". Box body shall have knock outs. Do not saw cut body. The minimum size box is as shown on Drawings. Increase box size as required to fit. Valve box lids are to indicate the controller letter and station number of valve as accepted by Owner's Representative. Also refer herein to required polyurethane tag at valve solenoid control wire under Control Wires. Locate the identification in center of the lid. Provide separate box for each valve. Provide H/20 Loading concrete boxes with bolt-down concrete lids for all valves that occur in paved areas.
- B. All Boxes & lids to be BLACK.

2.5 CONTROLLERS(S): As shown on Drawings and with the following minimum requirements:

- A. Shall be user-friendly. The controller must have a minimum 20-character readout display describing actions or options, or a full visible panel of buttons, dials, or switches that control all different functions separately.
- B. Shall have the ability to start a programmed sequence of valves a minimum of 5 times a day per program.
- C. Shall have ability to easily and quickly change watering schedules due to change in weather.
- D. Shall have real time weather tracking capability, and include a rain sensor and rain shut off switch.
- E. Flow Sensors: Compatible with Central Control System and as recommended by Control System manufacturer.
- F. Flow Monitors: Compatible with Central Control System and as recommended by manufacturer.
- G. Hand Held Remote Control: Portable device as manufactured by Control System manufacturer capable of operating all control valves.
- H. Master Control Valve: Master control valve shall be a 24 VAC, industrial type, solenoid control valve, Griswold 2000 series or approved equal. Valve shall be equipped with spring loaded packless diaphragm, cast iron body and bronze trim. The valve shall be of the normally closed type and shall be equipped with four-prong (cross) flow control. Valve shall be slow closing without chatter settings or adjustment. Valve shall have a mechanical self-purging internal control system with tapered, serrated, scrubbing rod through diaphragm for positive, variable port opening and cleaning. No solenoid port screens. Valve solenoid shall be corrosion-proof, molded in epoxy to form one integral unit with no connection shunts and shall be 24 VAC, 3 watt maximum.

2.6 CONTROL WIRES

- A. Connections between automatic controllers and the solenoid-operated electric control valves shall be made with direct burial copper wire 14- AWG-UF 600 volt (minimum size). Pilot wires shall be a color other than white, and shall be a different color for each automatic controller with wires sharing a common trench. Common wires shall be white in color, with a different color stripe for each controller with wiring sharing the same common trench. No stripe is required if multiple controller wiring is not present.
- B. Size of wire shall conform to the remote control valve manufacturer's specification for control wire sizes, but in no case shall the control wire be smaller than #14. Runs over 2,000 lineal feet shall be #12- AWG-UF 600 volt copper wire.
- C. All wire splices are to be made within a valve box, with a copper crimp-type connector, and a "3-M" #DBY splice kit or Rain Bird "DBTWC25".
- D. Use continuous control wiring between controllers and remote control valves (no splices).
- E. Provide polyurethane tag at valve solenoid control wire that shows the controller number and station number. Also refer to valve box lid identification.

- F. Provide a spare control wire in each RCV box for future.

2.7 LOW VOLUME MICRO SPRAY

- A. Pop-up as shown on drawings and with the following minimum requirements:
- B. Shall have minimum 20 psi water pressure coming out of nozzle.
- C. EXAMPLE – Rain Bird Xeri-Pop Micro-Spray, or approved equal.
- D. Shall not have spray blocked by turf or shrubbery; use 12" pop-ups.

2.8 BUBBLER HEADS

- A. As shown on drawings

2.9 QUICK COUPLER VALVES:

- A. Quick coupler valves shall be as listed on the Drawings with 10" diameter black box and black lid similar to isolation valve box described below.

2.10 ISOLATION VALVE:

- A. Valves 3 inches and smaller: 125 lb. WSP bronze gate valve with screw-in bonnet, non-rising stem and solid wedge disc, NIBCO T-113 K, or approved equal. Valves shall be line size.
- B. Valves larger than 2": shall have square nut stem and o-ring connections for key operation.

2.11 DRIP IRRIGATION

- A. Drip Manifold:
 1. Pressure Regulator: Preset at 30 psi outlet pressure, 3/4" female threaded inlet and outlet, by RainBird, Torro or approved equal.
 2. Emitters: Xeri-Bug (XB Series) by RainBird, Toro EZ Drip Series, or approved equal.
 3. Flexible PVC: ASTM D2287 algae-resistant flexible PVC as recommended by manufacturer of Drip Emitters or approved equal.
 4. Drip tubing: Conform to A. S. A. E. standards for minimum inside diameter and wall thickness, Minimum 2% carbon black, Salco 3/4" AR Drip PVC flexible drip hose, or approved equal.
 5. 3/4" Y-filter, 200 mesh or approved equal..
 6. Toro DL 2000 Air/Vacuum Relief Valves and In-line Spring Check Valves or approved equal..
 7. 3/4" manual PVC ball valve with extra 3' of hose coiled in valve box.
 8. Drip system in accordance with "RainBird Xerigation Low-Volume Landscape Irrigation Design Manual" and as shown on the drawings as required for a complete working system.

2.12 BOX FOR ISOLATION VALVE

- A. 10" diameter black plastic, Ametek, Brooks, Christy, Rain Bird with bolt down black lid marked "irrigation," or approved equal. Avoid locating valve in paved areas. Provide H/20 Loading concrete box with bolt-down concrete lid if valve is located in paved area. Obtain location approval by Owner's Representative. Black color.

2.13 SWING JOINTS

- A. Quick Coupling Valve: Dura 1-inch 1-A2-1-11-18 pre-assembled swing joint with O-rings and Dura quick lock to receive stabilizing rod or approved equal..

2.14 BACKFLOW PREVENTION DEVICE

- A. As required by Code and as shown on Drawings. Verify with Owner's Representative if Anti-freeze Jacket is required and provide as required.

- B. Riser assemblies from main line burial depth to backflow preventers shall be Schedule 40 brass pipe.
- C. All metallic pipe and fittings installed below grade shall be painted with two coats of Koppers #50 Bitumastic, or approved equal. Pipes may be wrapped with an approved asphaltic tape in lieu of the liquid-applied coating.
- D. Backflow preventer shall receive a minimum 6 inch thick concrete coordinated to fit backflow preventer enclosure as shown and as accepted by the Landscape Architect.

2.15 BACKFLOW PREVENTION DEVICE ENCLOSURE

- A. "Smooth Touch" enclosure without sharp edges, by Strong Box or approved equal, available from V.I.T., Escondido, CA (800) 729-1314 or equal. Coordinate size of enclosure with plumbing for minimum clearance and size. Enclosure to include concrete footing with hasp and staple to receive padlock. Padlock N.I.C.

2.16 CONDUIT/SLEEVES

- A. Sleeving shall be Schedule 40 PVC pipe sleeves and a minimum of two times the aggregate diameter of all pipes contained within the sleeve. Provide vertical sweep for all electrical conduit on each side of hardscape and terminate ends at 12" minimum depth and 12" from hardscape surface.

2.17 RCV IDENTIFICATION TAGS:

- A. Plastic or brass tags with valve number, approximately 2" by 2" with number imprinted, as accepted by Owner's Representative.

2.18 MISCELLANEOUS INSTALLATION MATERIALS

- A. Solvent Cement and Primers for Solvent-weld Joints: Make and type approved by manufacturer(s) of pipe and fittings. Maintain cement proper consistency throughout use.
- B. Pipe and Joint Compound: Permatex or approved equal: Do not use on sprinkler inlet port.

2.19 MISCELLANEOUS EQUIPMENT/ACCESSORIES

- A. Concrete for equipment pads (and thrust blocks if Bell-Type Pipe with O-Rings is required): Poured-in-place Class A concrete per Section 90 of the Caltrans Standard Specifications.
- B. Sleeves and Conduits: See Drawings.
- C. Key(s) for Quick-Coupling Valves:
 - 1. Type: Same manufacturer as Quick-Coupling Valve.

2.20 OTHER EQUIPMENT:

- A. As shown on Drawings and required for a fully functional irrigation system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Sleeves and Conduits: Verify that all installed sleeving and conduits are undisturbed and are free of defects or errors introduced by the work of other sections.
- B. Water Meter/Water Pressure: Test and verify that existing water pressure is the minimum pressure at maximum system g.p.m. to operate the irrigation system as indicated on the drawings.
- C. Stub-outs: Verify that all stub-outs to be provided under another contract are correctly sized, located and installed as noted on Drawings.

- D. Notification: Submit written notification to Owner's Representative within ten (10) working days of above inspections describing all acceptable and non-acceptable site conditions.

3.2 Trench LAYOUT/Interference with Tree Root Systems:

- A. Prior to trenching, layout main and lateral line locations within Drip Line of trees and review locations with Owner's Representative. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Owner's Representative.

3.3 CONNECTIONS TO SERVICES

- A. Provide and coordinate installation of irrigation dedicated water meter.
- B. Provide and coordinate connection of irrigation controller to electrical power source.

3.4 INSTALLATION

- A. Install irrigation system components in accordance with this Section, with the Drawings, with the manufacturer's recommendations, and with established industry standards. The Contractor shall do nothing that may jeopardize any manufacturer warranty.
- B. Conduits and Sleeves:
 - 1. Coordination: Provide conduits and sleeves and coordinate installation with other trades.
 - 2. Extent: Install conduits and sleeves where control wires and pipes pass under paving or through walls as shown on Drawings. Extend twelve inches (12") beyond edges of paving and walls and cap ends until ready for use.
- C. Excavating and Trenching:
 - 1. Pipe Layout: Layout pipe lines within Spread of Tree Branches as described above in TRENCH INTERFERENCE WITH TREE ROOT SYSTEMS.
 - 2. Dig trenches wide enough to allow a minimum of three inches (3") between parallel pipe lines. Provide a minimum cover from finish grade as follows:
 - a. 24-inches Deep: Over pipe on pressure side of irrigation control valve, control wires and quick-coupling valves.
 - b. 36-inches Deep: Over all pipe and pipe sleeves under roadways, parking lots, entrance to parking lots and Fire-Access Lanes per NFPA 24, Section 10.4.4.
 - c. 18-inches Deep: Over pipe on non-pressure side of irrigation control valve.
 - d. Direct Burial PVC Piping Under Pavement: Provide a minimum of 4 inches of sand backfill on all sides and 24 inches cover to bottom of paving.
- D. Pipeline Assembly:
 - 1. Install pipe and fittings in accordance with manufacturer's current printed Specifications.
 - 2. Clean all pipes and fittings of dirt, scale and moisture before assembly.
 - 3. Solvent-welded Joints for PVC Pipes:
 - a. Solvents: Use solvents and methods specified by pipe manufacturer.
 - b. Curing Period: Minimum of one (1) hour before applying any external stress on the piping and at least 24 hours before placing the joint under water pressure.
 - 4. Threaded Joints for Plastic Pipes:
 - a. Use Permatex or approved equal on all threaded PVC fittings except sprinkler heads and quick coupler valve ACME threads.
 - b. Joining: Use strap-type friction wrench only. Do not use metal-jawed wrench. Assemble finger tight plus one or two turns.
 - 5. Laying of Pipe:
 - a. Bedding On-grade: Remove from trench all rocks or clods. Bed pipe in at least 2 inches of soil excavated from trench. Backfill on all sides of piping to provide a uniform bearing.
 - b. Snaking: Snake pipe from side to side of trench bottom to allow for expansion and contraction. Minimum allowance for snaking is one (1) additional foot per 100 ft. of pipe.
 - c. Moisture Restrictions: Do not lay PVC pipe when there is water in the trench. Do not assemble PVC pipe unless the pipe is dry.

- E. Control Valves:
1. Install in valve boxes where shown on Drawings and group together where practical. Install box flush with finish grade, not necessarily level. If valve occurs in drainage swale, relocate out of drainage swale as approved by Owner's Representative.
 2. Where two or more valves are installed adjacent to each other, provide at least six inches (6") separation. Align boxes in a row, perpendicular with pavement edge.
 3. Permanently mark valve box lid with 2" black valve number and controller letter or with numbered metal tag inside box as approved by Owner's Representative.
 4. Refer to control wiring for required spare wire in each valve box.
- F. Low Volume Micro Spray Installation:
1. Pop-up Heads:
 - a. Place all sprinkler heads in planting areas with top of heads set to finish grade or top of mulch as required.
 - b. Place part-circle pop-up sprinkler heads two inches (2") from edge of and flush with top of adjacent walks, header boards, curbs and mowing bands or paved areas and 12 inches (12") from building foundations at time of installation.
 2. Bubblers:
 - a. Coordinate installation with planting contractor to insure timely and proper placement of heads at new planting.
- G. Drip Irrigation:
1. Install system in accordance with "RainBird Landscape Irrigation Design and Specifications Xerigation Products and Details" or equal and as shown on the Drawings as required for a complete working system.
 2. Install Toro DL 2000 Air/Vacuum Relief Valves or approved equal at high points in system.
 3. Install manual PVC ball valve with extra 3' of hose coiled in valve box at end(s) of collector laterals so that entire system will flush and be free of dirt and debris.
- H. Automatic Controller:
1. General: Install with lock box cutoff switch per local code and manufacturer's current printed specifications. Provide each controller with its own independent low voltage common ground wire.
 2. Connection to Valves: Connect remote control valves to controller in clockwise sequence to correspond with station setting beginning with Stations 1, 2, 3, etc.
 3. Labeling: Affix controller letter (i.e., "A") on inside of controller cabinet door with minimum of one-inch (1") high permanent letter.
 4. Irrigation Diagram: Affix a non-fading, waterproof copy of irrigation diagram to cabinet door below controller name. Irrigation diagram to be sealed between two plastic sheets, 20 mil. minimum thickness. Use a legible reduced copy of the Record Drawing for the irrigation diagram clearly showing all valves operated by the controller, station, number, valve size, and type of planting irrigated. Color code area operated by each valve.
- I. Control Wiring:
1. General: Install control wires in common trenches with sprinkler mains and laterals wherever possible. Lay to the bottom side of pipe line. Provide looped slack at valves. Snake wires in trench to allow for contraction of wires. Tie wires in bundles at 10 ft. intervals.
 2. Extra Length: Provide 30 inches (30") extra control wire at each remote control valve splice to facilitate the removal of the remote control bonnet to finish grade without cutting wires.
 3. Spare: Install one unconnected spare control wire running from the controller through each intermediate control valve box.
 4. Size: Minimum size of wire is to be determined strictly by the manufacturer's current printed specifications for remote control valves, but not smaller than #14.

5. Detection Wire: Install a bare #12 copper wire or greater on top of the PVC supply line for the purpose of possible future mine detection search. Install the control wires on the bottom of the PVC supply line with electrical tape every ten feet (10').
 6. Splicing: Crimp control wire splices at remote control valves. Seal with specified splicing materials. In-line splices will be allowed only on runs exceeding 2500 feet and only in junction boxes.
- J. Closing of Pipe and Flushing of Lines:
1. Capping: Cap or plug all openings as soon as lines have been installed to prevent entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.
- K. Rain Shutoff Switch:
1. Install switch in area not affected by irrigation or rain shadow. Provide wires in rigid conduit as accepted by Owner's Representative.
- L. Detection Wire and Warning Tape:
1. Install a bare # 12 copper wire or greater on top of the PVC supply line for the purpose of possible future mine detection search.
 2. Install a continuous PVC irrigation mainline warning tape 12" above the supply line.
- M. RCV IDENTIFICATION TAGS: Install in remote control valve box as recommended by manufacturer and as accepted by Owner's Representative.

3.5 MISCELLANEOUS EQUIPMENT

- A. Install miscellaneous equipment with concrete footings, brackets, etc., as required and as recommended by manufacturer.

3.6 FIELD QUALITY CONTROL

- A. Testing of Irrigation System:
1. Make hydrostatic tests with risers capped when welded PVC joints have cured at least 24 hours. Center load piping with backfill to prevent pipe from moving under pressure. Keep all couplings and fittings exposed.
 2. Install two (2) pressure gauges at opposite ends of main line system. Pump system up to a minimum of 125 psi the day preceding the scheduled test and verify that pressure is holding. Inspect system early following day and immediately notify Owner's Representative if the test confirmation must be postponed.
 3. Apply continuous static water pressure of 125 psi in accordance with Caltrans Standard Specifications Section 20-5.03H, except after a drop in pressure (5 psi maximum), then the pressure must stabilize and remain stable for a one (1) hour minimum period before acceptance of the test.
 4. Leaks detected during tests shall be repaired and test repeated until system passes tests at no additional cost to Owner's Representative.
- B. Irrigation Audit Report with Certificate of Completion
1. Per the requirements of the California Model Water Efficient Landscape Ordinance, the Contractor shall perform an irrigation audit and provide a report with certificate of completion to the local agency that may include, but is not limited to: inspection, system tune-up, system test with distribution uniformity, reporting overspray or run off that causes overland flow, and preparation of an irrigation schedule. Irrigation audits shall be conducted by a CLIA Certified landscape Irrigation Auditor by the Irrigation Association. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.
- C. Adjustment of the System:
1. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways and buildings. Adjust the arc and radius as applicable.

2. Include as a part of the work any nozzle changes or arc adjustments necessary due to daytime windy conditions during grass establishment period. After grass has been established and watering can be performed during calm early morning or evening hours, make any required adjustments to nozzles and arcs.
3. Set all sprinkler heads perpendicular to finished grades unless otherwise noted on the drawings.
4. When the landscape sprinkler system is completed and before planting, perform a coverage test in the presence of the Owner's Representative to determine if the water coverage for planting areas is adequate.
5. Test controllers individually in the presence of the Owner's Representative and the Landscape Architect. Demonstrate that all control valves operate electronically. Provide vehicles and radio equipment as necessary to expedite this process.
6. Demonstrate to Owner's Representative that irrigation scheduling programmed into controller is adequate for plant requirements without causing runoff, and that scheduling capacities of controller are utilized.

3.7 IRRIGATION SCHEDULING AND CONTROLLER PROGRAMMING

- A. Per the requirements of the California Model Water Efficient Landscape Ordinance All irrigation schedules and programs shall be developed, managed and evaluated to utilize the minimum amount of water required to maintain plant health.
- B. Irrigation controller Scheduling and Programming Parameters to be conducted by a CLCA Certified Irrigation manager and submitted to the local agency as part of the Certificate of Completion.
- C. Parameters used to set the automatic controller shall be developed for each of the following:
 1. Plant establishment period
 2. Established landscape period
 3. Temporary irrigated area (if applicable)
- D. Each irrigation schedule shall consider for each station all of the following that apply:
 1. Irrigation interval (days between irrigation)
 2. Irrigation run times (hours or minutes per irrigation event to avoid runoff)
 3. Number of cycle starts required for each irrigation event 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
- E. Total annual applied water shall be less than or equal to Maximum Applied Water Allowance (MAWA). Actual irrigation schedules shall be regulated by automatic irrigation controllers using current reference evapotranspiration data (CIMIS or soil moisture sensor data).

3.8 BACKFILL AND COMPACTING

- A. General: After system is operating and required tests and reviews have been made, backfill excavations and trenches with clean soil, free of debris.
- B. Backfill for All Trenches: Regardless of the type of pipe covered, compact to minimum 95% density under pavements and 85% under planted areas.
- C. Finishing: Dress off areas to finish grades. Re-dress any areas which subsequently settle.
- D. Owner's Representative's testing agency will test backfill compaction in areas under paving.

3.9 MAINTENANCE

- A. The entire sprinkler irrigation system shall be under full automatic operation for a period of 2 days prior to any planting.
- B. The Owner's Representative reserves the right to waive or shorten the operation period.
- C. Maintain/repair system for full duration of plant maintenance period.
- D. Pursuant to the requirements of the California Model Water Efficient Landscape Ordinance, the Owner's Representative is to provide a regular maintenance schedule with certificate of completion to the local water agency that may include, but is not limited to: routine inspection, adjustment and repair of the system and its components, aerating and dethatching turf areas, replenishing mulch, fertilizing, pruning, weeding, removing and obstruction to emission devices. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance. Systems to be maintained to meet or exceed an average landscape irrigation efficiency of 0.71.

3.10 REVIEWS PRIOR TO ACCEPTANCE

- A. Notify the Owner's Representative in advance for the following reviews, according to the time indicated:
 - 1. Supply line pressure test and control wire installation - 72 hours.
 - 2. Coverage and controller test - 72 hours.
 - 3. Final review - 7 days.
- B. No reviews will commence without record drawings, without completing previously noted corrections, or without preparing the system for review.

3.11 FINAL REVIEW AND CLEANUP

- A. Operate each system in its entirety for the Owner's Representative at time of final review. Any items deemed not acceptable by the Owner's Representative shall be reworked to the complete satisfaction of the Owner's Representative.
- B. Provide evidence to the Owner's Representative that the Owner's Representative has received all accessories and equipment as required before final review can occur.
- C. Final acceptance and start of warranty period will occur no earlier than the end of the plant maintenance period.
- D. For time of final review, Contractor shall arrange a meeting with the Owner's Representative's maintenance personnel to demonstrate the operation of the irrigation systems automatically in order to verify acceptance and to familiarize the maintenance personnel with the system and recommended programming.

END OF SECTION

SECTION 329000 PLANTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide planting work and planting maintenance complete as shown on the drawings and as specified including staking and layout of the landscaping and soil sampling as required by the State of California Model Water Ordinance.
- B. Related work specified elsewhere includes:
 - 1. Section 31 10 01, PLANT PROTECTION
 - 2. Section 32 84 00, IRRIGATION

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. Ordinances and Regulations: All local, municipal and state laws, codes and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship or construction of a better quality, higher standard than is required by the above mentioned codes and regulations, the provisions of these Specifications and Drawings shall take precedence. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.
 - 2. Contractor shall be familiar with and follow the State of California Model Water Ordinance, California Code of Regulations, Title 23 Waters, Division 2, Department of Water Resources, Chapter 2.7. Also, the Contractor is responsible to follow all local water ordinances and the Soil Management/Analysis Report with verifying implementation.
 - 3. "Sunset Western Garden Book," Lane Publishing Co., Menlo Park, California; current edition.
 - 4. "American Standards for Nursery Stock," American Association of Nurseryman, 230 Southern Building, Washington, D.C. 20005.
 - 5. Alameda Countywide Clean Water Program (ACCWP) or member agency having jurisdiction over the project work.
 - 6. US Composting Council Compost analysis Program (CAP)
 - 7. Test Methods for the Evaluation of Composting and Compost (TMECC)
 - 8. International Society of Arboriculture, Guide for Plant Appraisal, latest version.
 - 9. United States Composting Council (USCC) Seal of Testing Assurance (STA) program.
 - 10. TMECC: Refers to "Test Methods for the Examination of Composting and Compost," published by the United States Department of Agriculture and the United States Compost Council (USCC).
 - 11. Manufacturer's recommendations.
- B. Qualifications:
 - 1. Experience: Assign a full-time employee to the job as foreman for the duration of the Contract who is certified landscape technician, certification through CLCA or minimum of four (4) years experience in landscape installation and maintenance supervision, with experience or training in turf management, entomology, pest control, soils, fertilizers and plant identification.
 - 2. Labor Force: Provide a landscape installation and maintenance force thoroughly familiar with, and trained in, the work to be accomplished to perform the task in a competent, efficient manner acceptable to the Owner's Representative.
- C. Requirements:
 - 1. Supervision: The foreman shall directly supervise the work force at all times and be present during the entire installation. Notify Owner's Representative of all changes in supervision.

2. Identification: Provide proper identification at all times for landscape maintenance firm's vehicles and a labor force uniformly dressed in a manner satisfactory to Owner's Representative.
 3. Planting soils and organic amendments shall meet the AACWP requirement for the stormwater treatment measures used with this project work.
- D. Plant Material Standards
1. Quality and Size of Plants: Conform to the State of California Grading Code of Nursery Stock, No. 1 grade and American Standards for Nursery Stock," American Association of Nurseryman. Use only nursery-grown stock which is free from insect pests and diseases.
 2. Comply with federal and state laws requiring inspection for plant diseases and infestations. Submit inspection certificates required by law with each shipment of plants, and deliver certificates to the Owner's Representative. Obtain clearance from the County Agricultural Commissioner as required by law, before planting plants delivered from outside the County in which planted.
- E. Soil and Soil Amendment Testing and Analysis:
1. Soils Testing Agency: Soil and Plant Laboratory, Inc., 1101 Winchester Blvd., Suite G-173, San Jose, CA 95128, Tel. (408) 727-0330; or Root Zone Associates, P.O. Box 18911, San Jose, CA 95118; Tel. (408) 264-7024, or approved equal.
 2. All soils and organic soil amendments shall be submitted and tested by an accredited soils analyst. A standard soil analysis report shall identify sample source and include chemical analysis, fertility, agricultural suitability, and infiltration rates for soils. The report shall include all major nutrients, pH, salinity, boron, sodium, micronutrients, copper, zinc, manganese and iron, adsorption rate, organic content, soil texture and particle sizes. The report shall also include recommendations for modification of the soil(s) for agricultural suitability and compliance with the specified requirements, ordinances and regulations noted herein.
 3. Upon approval of the soils report by the Landscape Architect, the recommendations in the report shall become a part of the Specifications and the quantities of soil amendment, fertilizer and other additives shall be adjusted to conform with the report at no additional cost to the Owner's Representative. Request Testing Laboratory to send one copy of test results directly to Landscape Architect and one copy to the Owner's Representative.
 4. Topsoil Analysis Compliance Report
 - a. After approval of rough grading and topsoil placement, obtain minimum of two representative one quart samples of topsoil taken from accepted site locations at depth of 4" to 6" below finish grade and submit to an accredited Soils Laboratory for evaluation of physical and chemical properties of soil including all major nutrients; pH, salinity, boron, sodium, micronutrients, copper, zinc, manganese and iron; and infiltration rate, soil texture and organic content, along with a summary describing the degree of compliance with the specified requirements.
 - b. The existing topsoil analysis report will be used to identify any required additives that need to be added to the topsoil as well as identify if imported soils are compatible for use with the existing topsoil.
 - c. Submit documentation verifying implementation of soil analysis report recommendations.
 - d. The Contractor is responsible to follow all local water ordinances and make available to the local agency the soil analysis report and verification of its implementation as required.
- F. Coordinate plant locations with irrigation emitter locations.
1. Adjust plant locations in relation to the subsurface emitters as required to ensure that the plant roots receive the proper amount of water in order for it to thrive.
 2. Coordinate planting and irrigation and provide hand watering of emitter irrigated and drip irrigated areas as required to maintain moist root zones throughout plant establishment period.
- G. Damage from Deer, Rodents, Insects and Disease
1. Investigate planting for signs of damage from Deer, Rodents, Insects and Disease and provide repellents, barriers, or treatment and/or replacement upon discovery. Replace all damaged plants as described below in PLANTING ESTABLISHMENT MAINTENANCE.
- H. Mitigation of Lime Treatment of Site Soil.

1. If site work includes Lime Treatment of the site soil, the Contractor shall remove and replace the treated soil in all planting areas with approved imported planting soil and insure that the planting areas drain. If planting areas fail to properly percolate and drain, provide subsurface drainage structures as accepted by the Owner's Representative. Refer to PART 3 - EXECUTION for mitigation of the lime treated soil areas.

1.3 SUBMITTALS

- A. Submit to the Landscape Architect, Manufacturer's current catalog cuts and technical data sheets of the following:
 1. Fertilizers
 2. Iron Sulfate
 3. Tree and plant Ties /Support/Guying Materials
 4. Filter Fabric
 5. Erosion Control Netting
 6. Vine Support System
- B. Plants and Seeding Samples: Submit following planting samples along with certificates of compliance / analytical data from suppliers for degree of compliance and recommendations:
 1. Plants: Submit typical sample of each plant variety, or entire plant quantity to site for approval by Landscape Architect.
 2. Sod: Submit information of Sod Farm Company and type and percentage of sod mixture for approval by Landscape Architect.
 3. Turf Seed Mixes: Submit 1 cup sample with Analytical Data Sheet.
 4. Certificates of compliance for Hydroseed Mixes, Mulch and Tackifier for Erosion Control Seeding.
- C. Soil Amendment and Mulch Sample and Analysis Reports:
 1. Organic (Soil) Amendment(s): Submit 1-pint sample with certificate of compliance / analytical data sheet. For Composted Organic Amendment, include STA certification.
 2. Organic Mulch: Submit 1-pint sample with source and list of ingredients.
 3. Rock Mulch: Submit 1-pint sample(s) and source.
 4. Organic Soil Amendment Delivery Receipts
- D. Planting Soil(s): Submit 1 pint samples along with Laboratory certificates of compliance / analytical data sheet and recommendations, including but not limited to the required samples listed below. The sample submitted for testing shall be from the supplier's current soil source and dated less than 6 months prior to installation. State the name and location of the supply source. Upon approval of the Laboratory's recommendations by the Landscape Architect, the recommendations in the report shall become a part of the Specifications:
 1. Imported Site Makeup Planting Soil: For use in augmenting existing Site Planting Soil (TOPSOIL).
 2. Subsoil Analysis Sample.
 3. Existing Site Topsoil Analysis (Soil Management) Report.
 4. Bioswale Mineral Component (soil) Backfill.
 5. Imported Dewatering Planting Soil Material (Sandy Loam)
 6. Imported Treatment Planting Soil Material (Loamy Sand)
- E. Organic Soil Amendments Delivery Receipts
 1. Provide delivery receipts for quantities of organic soil amendments delivered to the site.
- F. Topsoil Analysis (Soil Management) Report

1. After approval of rough grading and topsoil placement, obtain minimum of three representative one quart samples of topsoil taken from accepted site locations at depth of 4" to 6" below finish grade and submit to an accredited Soils and Plant Laboratory for evaluation of physical and chemical properties of soil including all major nutrients; pH, salinity, boron, sodium, micronutrients, copper, zinc, manganese and iron; and infiltration rate, soil texture and organic content, along with a summary describing the degree of compliance with the specified requirements. The report shall also include recommendations for modification of the soil for agricultural suitability.
 2. Upon request by Owner's Representative, submit documentation verifying implementation of soil analysis report recommendations to the local agency with Certificate of Completion as required by the State of California Model Water Ordinance
- G. Subsoil Analysis Sample
1. Besides the above required soil samples, take one representative sample of any soil/subsoil that is to receive a layer of imported planting soil over it. The laboratory report shall include the soil/subsoil's total combined silt and clay content for determining the total desirable combined silt and clay content of the final imported planting soil cover specified herein.
- H. Approval of Laboratory Report
1. Upon approval of the Laboratory's report by the Landscape Architect, the recommendations in the report shall become a part of the Specifications and the quantities of soil amendment, fertilizer and other additives shall be adjusted to conform with the report at no additional cost to the Owner's Representative. Request Testing Laboratory to send one copy of test results directly to Landscape Architect and one copy to the Owner's Representative.
- 1.4 **PROJECT/SITE CONDITIONS**
- A. Site Visit: At beginning of work, visit and walk the site with the Owner's Representative to clarify scope of work and understand existing project/site conditions.
 - B. Protection of Plants from Deer: Contractor shall be responsible for protection of all planting from deer as described in Part 3- Execution.
- 1.5 **WARRANTY AND REPLACEMENT.**
- A. Warrant all plants and planting to be in a healthy, thriving condition until the end of the maintenance period, and deciduous trees, shrubs and vines beyond that time until active growth is evident.
 - B. Replace all dead and damaged plants and plants not in a vigorous condition immediately upon discovery and as directed by the Owner's Representative at Contractor's expense. Install replacement plants before the final acceptance at the size specified.
 - C. Warrant all plant material for a period of one year after final acceptance of the maintenance period against plant materials with defects at the time of installation.
 - D. Warrant plant installation and maintenance by Contractor against defects for a period of one year.

PART 2 - PRODUCTS

2.1 PLANTS

- A. Plant the variety, quantity and size indicated. The total quantity tabulated on the drawings are considered approximate and furnished for convenience only. Contractor shall perform his/her own plant quantity calculations and shall provide all plants shown on the Drawings. If plants are shown on the Drawings but are not identified, Contractor shall provide plants of similar size and variety to nearby identified plants at no additional cost to the Owner's Representative.
- B. Measure trees and shrubs with branches in normal position. Height and spread dimensions indicated refer to the main body of the plant, and not from branch tip to tip.
- C. Tag plants of the type or name indicated and in accordance with the standard practice recommended by the American Association of Nurserymen.

- D. Install healthy, shapely and well rooted plants with no evidence of having been root-bound, restricted or deformed.
- E. Ensure that the plants arrive at the site in proper condition for successful growth. Protect plants in transit from windburn and sunburn. Protect and maintain plants on site by proper storage and watering.
- F. Substitutions will not be permitted, except as follows:
1. If proof is submitted to the Landscape Architect that any plant specified is not obtainable, a proposal will be considered for use of nearest equivalent size or variety with an equitable adjustment of contract price.
 2. Substantiate and submit proof of plant availability in writing to the Landscape Architect within 10 days after the effective date of Notice to Proceed.
- G. Tree Form: Trees shall have a symmetrical form as typical for the species/cultivar and growth form.
1. Central Leader for Single Trunk Trees: Trees shall have a single, relatively straight central leader and tapered trunk, free of co dominant stems and vigorous, upright branches that compete with the central leader. Preferably, the central leader should not have been headed; however, in cases where the original leader has been removed, an upright branch at least 1/2 the diameter of the original leader just below the pruning point shall be present.
 2. Potential Main Branches: Branches shall be evenly distributed radially around and appropriately spaced vertically along the trunk, forming a generally symmetrical crown typical for the species.
 3. Headed temporary branches should be distributed around and along the trunk as noted above and shall be no greater than 3/8" diameter, and no greater than 1/2 diameter of the trunk at point of attachment.
- H. Tree Trunk
1. Trunk diameter and taper shall be sufficient so that the tree will remain vertical without the support of a nursery stake.
 2. Trunk shall be free of wounds (except properly-made pruning cuts), sunburned areas, conks (fungal fruiting-bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers and/or lesions.
 3. Tree trunk diameter at 6" above the soil surface shall be within the diameter range shown for each container size below, except where shown otherwise:

Container	Trunk Diameter in inches	Soil level from Container Top
5 gallon	0.5" to 0.75"	1.25 to 2"
15 gallon	0.75" to 1.0"	1.75 to 2.75"
4" Box	1.5" to 2.5"	2.25 to 3"
 4. Tree trunks shall be undamaged and uncut with all old abrasions and cuts completely callused over. Do not prune plants prior to delivery.
- I. Tree Roots
1. Trunk root collar (root crown) and large roots shall be free of circling and/or kinked roots. Contractor may be required to remove soil near the root collar in order to verify that circling and/or kinked roots are not present.
 2. The tree shall be well rooted in the container. When the trunk is lifted the trunk and root system shall move as one and the rootball shall remain intact.
 3. The top-most roots or root collar shall be within 1" above or below the soil surface. The soil level in the container shall be within the limits shown in above table.
 4. The rootball periphery shall be free of large circling and bottom-matted roots.
 5. On grafted or budded trees, there shall be no suckers from the root stock.
- J. Shrubs
1. Each shrub must stand upright without support.
 2. All container shrubs shall be free of girdling roots, defined as those roots greater than 1/8" diameter circling the periphery of the rootball. The top of the rootball shall be free of "Knees" (roots) protruding above the soil, and the bottom shall be free of matted roots.

2.2 FERTILIZERS

- A. Commercial fertilizer, pelleted or granular form, conform to the requirements of Chapter 7, Article 2, of the Agricultural Code of the State of California for fertilizing materials as follows:
1. Type A:
6% Nitrogen, 20% Phosphorus Acid and 20% Potash, (6-20-20).
 2. Type B:
21 gram planting tablets 20% Nitrogen, 10% Phosphoric Acid and 5% Potash (20-10-5) available from Agriform or 10gm BestPacks packets 20% Nitrogen, 10% Phosphoric Acid and 5% Potash (20-10-5) available from Best Fertilizer Co.
 3. Type C:
Complete fertilizer 21% Nitrogen, 7% Phosphoric Acid and 14% Potash (21-7-14).
 4. If commercial fertilizer having this analysis is not obtainable, other similar commercial fertilizer may be used providing it meets the approval of the Landscape Architect.
- B. Maintenance Fertilizer: Type C
- C. IRON SULFATE: Agricultural dry form

2.3 ORGANIC AMENDMENT: For use with in situ soils (on-grade)

- A. Ground Redwood or Ground Fir Bark with the following properties:

1.	<u>Percent Passing</u>	<u>Sieve Designation</u>	
	100	9.51 mm	3/8"
	50-60	6.35 mm	1/4"
	20-40	4.76 mm	No. 4
	0-20	2.38 mm	No. 8 8 mesh

Redwood Sawdust

Dry bulk density, lbs. per cu. yd., 260-280
Nitrogen stabilized - dry weight basis, min. 0.4%
Salinity (ECe): 4.0 maximum
Organic Content: 90% minimum
Reaction (pH): 4.0 minimum

Ground Fir and/or Pine Bark

Dry bulk density, lbs. per cu. yd., Min. 350
Nitrogen stabilized - dry weight basis, min. 0.5%
Salinity (ECe): 4.0 maximum
Organic Content: 90% minimum
Reaction (pH): 4.0 minimum

- B. Submittal: Submit sample along with analytical data from an approved laboratory for degree of compliance to the Landscape Architect within two weeks after award of Contract.

2.4 PLANT BACKFILL:

- A. Except for acid loving plants (Azaleas, Rhododendrons, Ferns, Camellias, etc.), use a mixture of 2 parts soil from the hole, and 1 part amendment with iron added at the following rates:

Size	Rate
1 gallon can plants	iron, 1/4 cup
5 gallon can plants	iron, 1/3 cup
15 gallon can plants	iron, 1/2 cup
24" box and larger	iron, 1 cup

1. Mix the iron, amendment and soil thoroughly for use only in the top 8 inches of backfill around plants. For acid loving plants, mixture to be 1/2 soil from the hole and 1/2 amendment only in the top 8 inches.
- 2.

2.5 MULCH

- A. Organic Mulch:
 - 1. Decorative Fir bark, dark in color; Medium 1/2-inch to 1-1/2-inc size.
- B. Submittal: Submit samples of organic and rock mulches to the Landscape Architect for approval within two weeks of award of Contract. Resubmit until acceptable to Owner's Representative, at no extra cost.

2.6 TREE SUPPORT POLES (ON-GRADE PLANTING): Peeled lodge pole pine logs, clean, smooth, new, and sized as follows:

- A. Support poles for trees up to 36" box size.
- B. Type: Peeled lodge pole pine logs, clean, smooth, new, and sized as follows:
 - 1. Two-inch (2") diameter by eight feet (8') long for trees less than 8' high and 1" caliper.
 - 2. Three-inch (3") diameter by eight to ten feet (8' - 10') long for trees greater than 8' high and 1-1/2" and larger caliper.

2.7 TREE TIES

- A. Rubber strap, 24-inch minimum length without sharp edges adjacent to trunk, V.I.T. cinch-tie, Dublin, CA, (818)882-9530, or approved equal.

2.8 TREE GUYING:

- A. Install guying if subgrade does not accept poles sufficiently to stabilize the tree, or unless otherwise noted on Drawings.
- B. For trees 3" to 6" caliper, 1/8" galvanized steel cable with 21" minimum long rubber tree collar, secured with cable clamp, 3" take-up eye to eye turnbuckle, and attached to anchor for below-grade location, Duckbill Model 68 DTS, or approved equal.
- C. For trees in raised planters, provide expansion bolt anchors into concrete planter walls and secure cables to anchor bolts as accepted by Owner's Representative.

2.9 EXISTING PLANTING SOIL (TOPSOIL):

- A. Existing Planting Soil (TOPSOIL) is defined as on-site surface soil. Satisfactory planting soil shall be free of subsoil, clay, lumps, stones, and other objects over 4" in diameter, and without weeds, roots, and other objectionable material.
- B. Strip planting soil to whatever depths encountered, a maximum of **12** inches in a manner to prevent intermingling with the underlying subsoil or other objectionable material. Topsoil stripping is limited to area outside "Drip Line" of existing trees to remain and areas indicated on drawings and as approved by the Owner's Representative.
- C. Remove heavy growths of grass from areas before stripping.
- D. Stockpile topsoil in storage piles in areas shown, or where designated by Owner's Representative. Do not mix topsoil with subsurface soils. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent windblown dust.
- E. If herbicide contamination is suspected then a radish/ryegrass growth trial must be performed. Consult with Landscape Architect prior to decision to test or not.
- F. If sufficient on-site surface topsoil is not available, provide imported planting soil as specified below. Placement of dissimilar soils shall be coordinated with irrigation system valving to maintain separate valves for dissimilar soils.

2.10 SUBSOIL SAMPLING SUBMITTAL (Existing Site Soil)

- A. Contractor to obtain a minimum of one representative sample of existing site soil from approved site soil location(s) where any subgrade soil is to receive a layer of imported planting soil over it and submit sample to an accredited Soils Laboratory for analysis and comparison to imported soil for evaluation of compatibility. The laboratory report shall show chemical analysis stating source, fertility, agricultural suitability and particle size including total combined silt and clay content for determining the total desirable combined silt and clay content of the imported planting soil.
- B. Submittal: Submit sample and analysis report for approval by the Landscape Architect as noted in PART 1, Submittals.

2.11 IMPORTED PLANTING SOIL (TOPSOIL):

- A. Imported Planting Soil for general use in augmenting existing Site Planting Soil shall be fertile, friable, natural, productive soil containing a normal amount of humus, and shall be capable of sustaining healthy plant life. Imported planting soil shall be screened and shall be free of subsoil, heavy or stiff clay, rocks, gravel, brush, roots, weeds, noxious seeds, sticks, trash, and other deleterious substances. Soil shall not be infested with nematodes or with other noxious animal life or toxic substances. Soil shall be obtained from well-drained, arable land, and shall be of an even texture. Soil shall not be taken from areas on which are growing any noxious weeds such as Morning Glory, Sorrel, or Bermuda Grass.
- B. Imported Planting Soil shall have a pH value of between 6.0 and 7.5, a boron concentration of the saturation extract of less than 1 ppm, salinity of the saturation extract at 25 degrees C. of less than 4.0 millimoles, and a sodium absorption rate (SAR) of less than 8.
- C. The silt and clay content of Imported Planting Soil shall not exceed that of the existing soil it is to be placed over. Except where otherwise required, it shall be a "Sandy Loam" as classified in accordance with USDA Standards with a combined total of between 25% to 40% Clay and Silt.
- D. Submittal: submit for approval a 1-quart sample of proposed import soil, together with a standard soil analysis report by an accredited soils analyst showing chemical analysis stating source, fertility, agricultural suitability and particle size distribution of the soil. Deliver the sample to the Landscape Architect minimum two weeks before starting the contemplated hauling of the soil.
- E. Submittal: Also, provide Existing Site Soil sample analysis report for comparison with the Imported Planting Soil report.
- F. Following approval of the sample, provide a one-half cubic yard sample, which shall be stored at the site of work for comparison with subsequent loads of soil. The comparison sample shall be protected by a cover until the furnishing of all soil has been completed and accepted. Should the soil submittal lack certain requirements which can be added to the soil, the Landscape Architect will consider a request by the Contractor to amend the soil as recommended by the Soils Analyst at the Contractor's expense.

2.12 IMPORTED DEWATERING PLANTING SOIL MATERIAL (SANDY LOAM)

- A. Planting soil material for surface dewatering shall consist of soil (no Gravel) with a moderate percolation rate (2 to 10 inches per hour) supplied from previously tested and approved sources, and shall conform to the following guidelines:
 - 1. All material shall be free of trash and debris, expansive clays or any other deleterious materials and shall be subject to the approval and acceptance of the Authority Having Jurisdiction.
 - 2. Designate proposed import source in advance and provide source samples of material to the jurisdiction having authority.
 - 3. Material shall be free of seeds.
 - 4. The dewatering planting soil material shall have documentation from supplier showing conformance to the following gradation guidelines:

	Screen Information	Percentage
a.	Maximum Particle Size	2mm (0.078 inch)
b.	% passing No. 10 screen (2mm)	100 (coarse sand or finer)

- c. % passing No. 200 screen (0.074mm) 15 to 50 %
 - d. The 15 to 50% passing #200 sieve is silt, clay and organics, with a range of silt from 5-35% and a clay content of 4-20%.
5. The above screened dewatering planting soil shall have 4 to 6% by dry weight approved organic compost mixed in. Final dry weight per unit volume mixed in may be lowered by the jurisdiction having authority for varying plant species in the treatment measure/area(s). Native in-situ Sandy Loam soils can be used, with 4 to 6% by weight of organic compost mixed in, if approved by the jurisdiction having authority. This native soil used must be certified to meet the imported planting soil guidelines. Organic compost shall meet the Organic Compost Amendment guidelines stated herein.
 6. Contractor shall demonstrate the in-situ percolation of each treatment measure/area for design storm flows through the installed soil to the satisfaction of the Authority Having Jurisdiction. The material shall have an onsite tested percolation rate of 2 to 10 inches per hour. Contractor shall provide records of percolation test to City Inspector.
 7. Standard compaction of a minimum of 85% relative compaction shall be used when placing the mixed material. Complete inundation of the soil shall be used to reach this compaction. Place soil in lifts of 8 to 10 inches.
- B. Note: Lower percolation rate of dewatering soil may be allowed by the local jurisdiction.
- C. Submittal: submit for approval a 1-quart sample of proposed IMPORTED DEWATERING PLANTING SOIL MATERIAL, together with a standard soil analysis report by an accredited soils analyst showing chemical analysis stating source, fertility, agricultural suitability, particle size distribution of the soil and percolation rate. Deliver the sample to the Owner's Representative minimum two weeks before starting the contemplated hauling of the soil.

2.13 IMPORTED TREATMENT PLANTING SOIL MATERIAL (LOAMY SAND)

- A. Planting soil material for treatment shall consist of soil (no Gravel) with a high percolation rate supplied from previously tested and approved sources, and shall conform to the following guidelines:
1. All material shall be free of trash and debris, expansive clays or any other deleterious materials and shall be subject to the approval and acceptance of the Authority Having Jurisdiction.
 2. Designate proposed import source in advance and provide source samples of material to the jurisdiction having authority.
 3. Material shall be free of seeds.
 4. The dewatering planting soil material shall have documentation from supplier showing conformance to the following gradation guidelines:

Screen Information	Percentage
a. Maximum Particle Size	2mm (0.078 inch)
b. % passing No. 10 screen (2mm)	100 (coarse sand or finer)
c. % passing No. 200 screen (0.074mm)	10 to 15%
d. The overall dry weight percentages shall be 85-90% sand, less than 5% clay, and less than 5% silt. The range of clay and silt and organics should be 10-15% of total volume.	
 5. The above screened dewatering planting soil shall have 4 to 6% by dry weight approved organic compost mixed into the top 6 inches of soil, and 0 to 3% mixed into the soil below 6 inches from finish grade. Final dry weight per unit volume mixed in may be lowered by the jurisdiction having authority for varying plant species in the treatment measure. Native in-situ Sandy Loam soils can be used, with 4 to 6% by weight of organic compost mixed in, if approved by the jurisdiction having authority. The native soil used must be certified to meet the imported planting soil guidelines. Organic compost shall meet the Organic Compost Amendment guidelines stated herein. The soil shall have a salt concentration less than 500 mg/L. The pH shall be between 5.5 and 7.1, unless directed otherwise by the Jurisdiction of Authority.
 6. Contractor shall demonstrate the in-situ percolation of each treatment measure/area for design storm flows through the installed soil to the satisfaction of the Authority Having Jurisdiction. The material shall have an onsite tested percolation rate of 5 to 10 inches per hour. Contractor shall provide records of percolation test to City Inspector.

7. Standard compaction of a minimum of 85% relative compaction shall be used when placing the mixed material. Complete inundation of the soil shall be used to reach this compaction. Place soil in lifts of 8 to 10 inches.
- a.

- B. Submittal: submit for approval a 1-quart sample of proposed IMPORTED TREATMENT PLANTING SOIL MATERIAL, together with a standard soil analysis report by an accredited soils analyst showing chemical analysis stating source, fertility, agricultural suitability, particle size distribution of the soil and percolation rate. Deliver the sample to the Owner's Representative minimum two weeks before starting the contemplated hauling of the soil.

2.14 **BIOSWALE PLANTING SOIL BACKFILL MIX:**

- A. Bioswale backfill mix to receive planting shall be as specified below and as shown in Drawings:

BIOSWALE SPECIFICATION GUIDELINES

(Courtesy of Soil & Plant Laboratory, Inc. Santa Clara, CA)

For the filtration of runoff water before it enters the storm drain system

The mineral component shall be classified as USDA sand or loamy sand and shall conform to the following particle size and characteristics.

US Sieve Size (mm)	Class	% wt. retained
#10 2.0	Gravel	0-10
#270 <0.05	Silt & Clay	6-12

Rock ½ inch – 1 inch = 0-5% by volume with none > 1 inch
 Organic = 0-3% by weight for below 6 inches from finish grade

B. PERCOLATION RATE

Must fall in the range of 10 inches per hour Initial Rate and 5 inches Sustained rate as determined by SPL method A06-2.

C. CHEMISTRTY SUITIBILITY CONSIDERATIONS

1. Salinity: Saturation Extract Conductivity (ECe) Less than 3.0 dS/m @ 25o C.
 Sodium: Sodium Adsorption Ratio (SAR) Less than 6.0
 Boron: Saturation Extract Concentration Less than 1.0 ppm
 Reaction: pH of Saturated Paste: 5.5 – 7.8 without high lime content.

- D. SUBMITTAL: To insure conformance submit ½ gallon sample for analytical packages; A06-2, A05-1 to Soils & Plant Laboratory, Santa Clara, CA.

E. PROFILE PREPARATION

NOTE: If organic content of the mineral component is less than 0.6% weight, then it should be blended with *compost in volume proportions of 5% compost to 95% mineral.

- F. After placement the top 6 inches should be blended with *compost. If bulk blended, proportions should be 1 part compost to 4 parts of the above mineral component. If blended in place this would be equivalent to 4 ½ cubic yards per 1000 square feet for blending to 6 inches.

- G. * **Compost** to comply with Yard Waste Compost specifications on the enclosed form #415.

H. YARD WASTE COMPOST -FORM #415 SPECIFICATIONS GUIDELINES
 (Courtesy of Soil & Plant Laboratory, Inc. Santa Clara, CA)

- I. Gradation: A minimum of 90% of the material by weight shall pass a ½" screen. Material passing the ½" screen shall meet the following criteria.

J. Percent Passing Sieve Designation

85 – 100	9.51 mm (3/8")
50 – 80	2.38 mm (No. 8)
0 – 40	500 micron (No. 35)

1. Organic content: Minimum 50% based on dry weight and determined by ash method. Minimum 250 lbs. organic matter per yard of compost.
 2. Carbon to nitrogen ratio: Maximum 35:1.
 3. pH: 5.5 – 8.0 as determined in saturated paste.
 4. Soluble salts: Soluble nutrients typically account for most of the salinity levels but sodium should account for less than 25% of the total. To avoid a leaching requirement, the addition of the compost shall result in a final ECe of the amended soil of less than 4.0 dS/m @ 25 degrees C. as determined in a saturation extract.
- K. Use the following table to determine the maximum allowable ECe (dS/m of saturation extract) of compost at the desired use rate.

Desired Use Rate		Salinity (ECe) of On-Site Soil		
Cu. Yds. Amendment per 1000 sq. ft. for incorporation to 6" depth	Volume Percentage of Amendment	3 dS/m	2 dS/m	1 dS/m
		Maximum ECe of Compost		
2	11	7	14	21
3	16	5	9.5	14
4	22	3.5	7	10.5
5	27	3	5.5	8.5

- L. Example: Specification calls for 4 cu. yds. Compost per 1000 sq. ft. to a 6" depth, and site soil has an ECe of 2.0.
- M. In order to avoid exceeding an ECe of 4 in the final blend, compost ECe should be less than 5.5 dS/m.

1. Contaminants: The compost shall be free of contaminants such as glass, metal and visible plastic. Heavy metals, fecal coliform, and Salmonella sp shall not exceed levels outlined in California Integrated Waste Management regulation/
2. Maturity characteristics:
 - a. Color: dark brown to black
 - b. Odor: Acceptable = none, soil-like, musty or moldy Unacceptable = sour, ammonia or putrid
 - c. Particle characterization: Identifiable wood pieces are acceptable but the balance of material should be soil-like without recognizable grass or leaves.

N. Bioswale Backfill Mix is available from TMT Enterprises, www.tmtenterprises.net, (408) 432-9040, 1996, San Jose, CA; American Soil and Stone, in Richmond, CA (510) 292-3000 and San Rafael, CA (415) 456-1381; and Lyngso Garden Materials, www.lyngsogarden.com, (650) 364-1730, Redwood City, CA or approved equal.

O. Submittal: submit for approval a 1-quart sample of proposed BIOSWALE PLANTING SOIL BACKFILL MIX, together with a standard soil analysis report by an accredited soils analyst showing chemical analysis stating source, fertility, agricultural suitability, particle size distribution of the soil and percolation rate. Deliver the sample to the Owner's Representative minimum two weeks before starting the contemplated hauling of the soil.

2.15 EROSION CONTROL NETTING

- A. New, with a uniform, open plain-weave, flame-retardant mesh. The mesh shall be [natural brown-tan] and made from unbleached single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than one-half its normal diameter. Furnish jute mesh in rolled strips to meet the following requirements:
1. Width: 48 inches, with a tolerance of one-inch wider or narrower.
 2. Not less than 78 warp ends per width.

3. Not less than 41 weft ends per yard.
4. Weight shall average 1.22 pounds per linear yard, with a tolerance of 5 percent heavier or lighter.

2.16 VINE TIES:

- A. Provide vertical supports for all vines as required for vines to climb onto shown horizontal supports (trellis, arbor, etc.). Vertical support shall be clear vinyl coated 3/16" galvanized steel cables secured taut with cable clamps at base and top of structure. If a suitable connection point at base of structure is unavailable, anchor the cable in ground with 1 inch by 15 inch galvanized pipe stake driven flush with drilled hole to receive the cable, or similar approved method. Train vine branches to supports with green nursery tape.

PART 3 - EXECUTION

3.1 FINE GRADING AND SOIL PREPARATION

- A. General
 1. Soil in all planting areas shall be moist, but not so moist that it sticks to a hand shovel, and loose and friable to a minimum depth of 12 inches with a relative maximum compaction of 85%. Rip and scarify and dry any areas that do not meet this requirement.
- B. Before proceeding with the work: Carefully inspect all areas and verify all dimensions and quantities. Immediately inform the Landscape Architect of any discrepancy between the drawings and specifications and actual conditions and secure approval to proceed.

3.2 Lime Treated Soil Removal

- A. All Lime treated soils shall be removed full depth of treated soil from planting areas where it occurs and replaced with approved planting soil as accepted by Owner's Representative.
- B. As-Built Drawing Requirement: Contractor shall field measure and record all lime treated areas on As Built Drawings showing both depth and extent of areas treated to aid in subsequent removal of material in planting areas.
- C. Following removal of lime treated material, scarify subgrade to a minimum depth of 6 inches and test for drainage.
- D. Test subgrade in all planting areas for drainage by flooding with minimum 4 inch depth of water puddle and verify complete absorption of standing water within two hours. If standing water is still present after two hours, provide perforated pipe and drain rock "French Drain" system in bottom of non-draining planters and connect to storm drainage system, as accepted by Owner's Representative prior to backfilling with approved planting soil.

3.3 PLANTING SOIL PLACEMENT

- A. Planting Soil Placement:
 1. Inspect planting areas and remove all base rock and other foreign material. Verify placement of planting soil within dripline of trees with Owner's Representative. Except within tree driplines, rip all planting areas in two directions full depth of compacted fill (to a minimum of 12 inches) into undisturbed native soil prior to backfilling. Scarification of any planting area which cannot be accomplished with a tractor shall be accomplished by an alternative method approved by the Owner's Representative to the specified depth to ensure proper percolation/drainage.
 2. Prior to placing planting soil secure the Owner's Representative's acceptance of the planting areas subgrade condition. Test depth of loose soil with hand shovel in presence of Owner's Representative in several locations as directed. After acceptance of the planting areas subgrade condition, uniformly distribute and spread planting soil backfill over scarified subgrade in planting areas as specified and compact to a maximum of 85% relative compaction.
 3. Do not work planting soil in a wet or muddy condition or dump or spread in areas where subgrade is not in proper condition.

4. Water settling, puddling, and jetting of fill and backfill materials as a compaction method is not acceptable.
 5. Provide a minimum of [12"] depth in planting areas, or more where shown or specified otherwise.
- B. Planting Soil Placement in Planting Islands and Adjacent to Pavement Areas:
1. Provide planting soil as a final lift in all planting areas within and adjacent to paved areas and other construction where native site soil has been covered by engineered fill and/or base rock. Remove all engineered fill, base rock and compacted subgrade full depth of compaction and replace with approved planting soil, a minimum lift of [12"]. Unless shown otherwise, finish grade in planting islands shall be crowned with a minimum 2 % pitch to the edges.
- C. All planting areas soil shall be loose and friable prior to planting. Rip any overly compacted and re-compacted planting areas in two directions full depth of compacted soil prior to planting.
- D. Planting operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped until conditions are satisfactory.
- E. Thoroughly wet down the planting areas to settle the soil and confirm irrigation coverage and operation. Allow soil to dry so as to be workable as described herein.
- F. Drag to a smooth, even surface. Grade to form all swales. Pitch grade with uniform slope to catch basins, streets, curb, etc., to ensure uniform surface drainage. Areas requiring grading include adjacent transition areas that shall be uniformly sloped between finish elevations. Slope surface away from walls so water will not stand against walls or buildings. Control surface water to avoid damage to adjoining properties or to finished work on the site. Take required remedial measures to prevent erosion of freshly graded areas and until such time as permanent drainage and erosion control features have been installed. Refer to Erosion Control Netting below for treatment of slopes 3:1 and steeper.
- G. Finish Grade: Hold finish grade and/or mulch surface in planting areas 1/2-inch below adjacent pavement surfaces, tops of curbs, manholes, etc. The subgrade of the mulch in mulched planting areas shall be a minus 2 inches for a distance of 12 to 18 inch from the edge of pavement. The remainder of the planting area shall be graded to receive the required 3 inch layer of mulch.
- H. In Situ Soil Preparation:
1. Spread organic amendment, iron and Type A fertilizer evenly over installed and rough graded on-site topsoil in all planting areas including turf, ground cover and shrub areas at the following rates:
 - a. Organic Amendment: 6 cubic yards per 1,000 square feet
 - b. Fertilizer: Type-A (6-20-20) at 20 lbs. per 1,000 square feet.
 - c. Iron Sulfate: 10 lbs. per 1,000 square feet
 2. In the case of a contradiction between the quantity of organic amendment required by the Contractor-obtained soils laboratory analysis and the specified quantity shown above, the greater of the two quantities shall take precedence.
 3. Rototill above additives into soil 6 to 8 inches deep. Keep iron sulfate off pavement and other surfaces to prevent rust staining. Correct all rust damage to work.
 4. Planting soil shall have a pH range of 6.5 to 7.5.
- I. After the rototill work, float areas to a smooth, uniform grade as indicated on the drawings. Slope all planting areas to drain. Roll, scarify, rake and level as necessary to obtain true, even planting surfaces. Remove rocks, sticks and debris 1 inch and larger in size in turf areas and 2 inches or larger in shrub and ground cover areas. Secure approval of the grade by the Landscape Architect before any planting.

J.

3.4 BIOSWALE PLANTING SOIL BACKFILL MIX

- A. Install the above specified bioswale backfill mix as shown in Drawings after approval of the drainage material installation.

3.5 EROSION CONTROL NETTING

- A. Verify finished grades and provide Jute Mesh with single grind Redwood bark mulch over the mesh on all slopes 3:1 and steeper as accepted by the Owner's Representative. Install jute mesh loosely up and down the slope in accordance with manufacturer's specifications and as follows. Fit the soil surface contour and hold in place with 12-inch long, 11-gauge (minimum) steel wire staples driven vertically into the soil at 18- to 24-inch spacing. Jute mesh strips shall overlap along all edges at least 6 inches. Ends of side strips shall be buried into the soil at least 6 inches. Drive staples along edges to securely anchor mesh to ground.

3.6 TREE AND SHRUB PLANTING

- A. Mark tree and shrub locations on site using stakes, gypsum or similar approved means and secure location approval by the Landscape Architect before plant holes are dug. Review location of plants in relationship to irrigation heads and adjust location(s) that interfere with the function of the spray heads as accepted by the Landscape Architect prior to planting.
- B. Test drainage of plant beds and pits by filling with water (minimum 6"). The retention of water in planting beds and plant pits for more than two (2) hours shall be brought to the attention of the Landscape Architect. If rock, underground construction work, tree roots, poor drainage, or other obstructions are encountered in the excavation of plant pits, alternate locations may be selected by Landscape Architect.

- C. Excavate tree, shrub and vine pits as follows:

<u>Excavation for</u>	<u>Width</u>	<u>Depth</u>
Boxed Trees	Box + 24"	depth of Box
Canned Trees (15 gc)	Can + 18"	depth of Can
Canned Shrubs/Vines (1 or 5 gc)	Can + 12"	depth of Can

- D. Break and loosen the sides and bottom of the pit to ensure root penetration and water test hole for drainage as required above.

- E. Backfill plant holes with mix as specified, free from rocks, clods or lumpy material. Backfill native soil free of soil amendments under rootball and foot tamp to prevent settlement. Backfill remainder of the hole with soil mix and place plant tablets or packets (Type B fertilizer) 3 inches below finish grade and 1/2-inch from roots at the following rates:

<u>Size</u>	<u>Rate</u>
1 gallon can plant -	1 tablet or packet
5 gallon can plant -	3 tablets or packet
15 gallon can plant -	6 tablets or packet
24-inch box plant -	6 tablets or packet
36-inch box plant -	8 tablets or packet

- F. Carefully remove and set plants without damaging the rootball. Superficially cut edge roots vertically on three sides. Remove bottom of plant boxes before planting. Remove sides of boxes after positioning the plant and partially backfilling.
- G. Set plants in backfill with top of the rootball 2 inches above finished grade. Backfill remainder of hole and soak thoroughly by jetting with a hose and pipe section. Water backfill until saturated the full depth of the hole.
- H. Build 6" high watering basin berms around trees and shrubs to drain through rootball. Basins are not required around trees in turf areas.
- I. Stake and/or guy trees as detailed and noted herein. Drive stake(s) until solid (at least 12" beyond bottom of rootball) and remove excess stake protruding above top tree tie to prevent rubbing against branches. Avoid driving stakes through rootball. If subgrade does not accept stakes to a stable degree, delete stakes and guy the trees as specified herein and as detailed. Locate tree ties to avoid contact with tree branches. Locate top tie at tree flex point.
- J. Guy Trees using 3 cables with below grade anchors and rubber collars secured with cable clamps.
- K. Remove any soil from top of plant rootballs and secure Landscape Architect's approval of rootball height prior to mulching.

- L. After approval of rootball height, install mulch as required below.

3.7 GROUND COVER PLANTING

- A. Plant in neat, straight, parallel and staggered rows as indicated on plan. Plant first row one-half required ground cover spacing behind adjacent curbs, structures, or other plant bed limits. Plant ground cover to edge of water basins of adjacent trees and shrubs.

3.8 MULCH

- A. Except where rock mulch is required, mulch all tree, shrub and ground cover areas with organic mulch to a 3-inch depth, except adjacent to walkways where soil grade is 2 inches below top of pavement, mulch shall be 2 inches deep, and 2-inches deep where planting ground cover plants from flats. Hold bark mulch away from base (trunk) of plant 4" or as directed by the Landscape Architect. Individual trees and/or shrubs planted in non-irrigated areas shall, at minimum, receive bark mulch over their watering basin and berm. No mulch is required around trees in turf areas.

3.9 WATERING

- A. Water all trees, shrubs and ground cover immediately after planting. Apply water to all plants in sufficient amounts as conditions require to maintain the plants in a healthy vigorous growing condition until completion of the Contract. Do supplemental hand watering of plants as required to maintain optimum moisture in the root zones.

3.10 PRE-MAINTENANCE PERIOD REVIEW AND APPROVAL OF PLANTING

- A. Maintain plants from time of delivery to site until final acceptance of landscape installation.
- B. Receive approval of the installed planting prior to commencement of planting establishment maintenance period. Notify the Landscape Architect a minimum of seven (7) days prior to requested review. Before the review, complete the following:
 1. Complete all construction work.
 2. Present all planted areas neat and clean with all weeds removed and all plants installed and appearing healthy.
 3. Plumb all tree stakes.
 4. No partial approvals will be given.

3.11 PLANTING ESTABLISHMENT MAINTENANCE

- A. General Requirements:
 1. Maintenance Period: The planting establishment maintenance period required shall be [120] calendar days after all planting is complete, turf is seeded, and installation approved. A longer period may be required if the turf is not thick, vigorous and even and has been mowed a minimum of 4 times, or if the plant material is not acceptably maintained during the maintenance period. The maintenance period may be suspended at any time upon written notice to the Contractor that the landscaping is not being acceptably maintained, and the day count suspended until the landscape is brought up to acceptable standards as determined by the Landscape Architect.
 2. Planting establishment maintenance immediately follows, coincides with, and is continuous with the planting operations, and continues through turf installation, and after all planting is complete and accepted; or longer where necessary to establish acceptable stands of thriving plants.
 3. Keep all walks and paved areas clean. Keep the site clear of debris resulting from landscape work and maintenance operations.
 4. Check sprinkler systems at each watering; adjust coverage and clean and repair non-functioning heads immediately. Adjust timing of sprinkler controller to prevent runoff and flooding.
 5. Maintain adequate moisture depth in soil to ensure vigorous growth, without overwatering. Check rootball of trees and shrubs independent of surrounding soils and hand water as required.

6. Keep Contract areas free from weeds by cultivating, hoeing or hand pulling. Use of chemical weed killers will not relieve the Contractor of the responsibility of keeping areas free of weeds over 1-inch high at all times.
- B. Plant Protection and Replacement
1. Protect all areas against damage, including erosion, trespass, insects, rodents, deer, disease, etc. and provide proper safeguards, including trapping of rodent and applying protective sprays and fencing to discourage deer browsing. Maintain and keep all temporary barriers erected to prevent trespass.
 2. Repair all damaged planted areas. Replace plants and reseed or resod turf immediately upon discovery of damage or loss, including damage from Deer and Rodents.
- C. Tree, Shrub and Ground Cover Maintenance:
1. Maintain during the entire establishment period by regular watering, cultivating, weeding, repair of stakes and ties, and spraying for insect pests. Prune when requested by the Landscape Architect.
 2. Keep watering basins in good condition and weed-free at all times.
 3. Replace all damaged, unhealthy or dead trees, shrubs, vines and ground covers with new stock immediately; size as indicated on the drawings.
- D. Fertilizing:
1. Upon approval and after submitting fertilizer delivery tags, maintenance fertilization shall begin 30 days after planting is complete. Fertilize all turf and ground cover areas by broad-casting Type C (21-7-14) fertilizer at the rate of 5 lbs. per 1,000 square feet evenly throughout. Reapply every forty-five (45) days until acceptable.
 2. Early spring and fall substitute a complete fertilizer such as 15-15-15 applied at the rate of 6 lbs. per 1,000 square feet, to help insure continuing adequate phosphorus and potassium.
 3. Apply ammonium sulfate fertilizer as necessary to maintain vigorous, green grass between fertilizings mentioned above.
 4. Observe plant's color, and if a soil pH imbalance is suspected, take soil samples and obtain laboratory analysis for confirmation. Take necessary action recommended in laboratory analysis such as top dressing with soil sulfur, leaching soil, etc.

3.12 FINAL PLANTING REVIEW AND ACCEPTANCE

- A. At the conclusion of the Maintenance Period, schedule a final review with the Owner's Representative, the Owner's maintenance person, and the Landscape Architect. On such date, all project improvements and all corrective work shall have been completed. If all project improvements and corrective work are not completed, continue the planting establishment, at no additional cost to the Owner's Representative, until all work has been completed. This condition will be waived by the Owner's Representative under such circumstances wherein the Owner's Representative has granted an extension of time to permit the completion of a particular portion of the work beyond the time of completion set forth in the Agreement.
- B. Submit written notice requesting review at least 10 days before the anticipated review.
- C. Prior to review, weed and rake all planted areas, repair plant basins, mow and edge turf, plumb tree stakes, clear the site of all debris and present in a neat, orderly manner.

END OF SECTION

SECTION 330516 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 312333 – Trenching and Backfilling.
- B. Section 334000 – Storm Drainage Utilities.
- C. Section 320523 – Cement and Concrete for Exterior Improvements.

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 Caltrans Standard Specifications.
 - 1. Section 51, Concrete Structures.
 - 2. Section 75, Miscellaneous Metal.

1.4 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials.
- B. ASTM: American Society for Testing Materials.

1.5 SUBMITTALS

- A. Follow submittal procedures outlined in Section 013300 – 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.

PART 2 PRODUCTS

2.1 CLEANOUTS

- A. Piping: Same as sanitary sewer 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. Non-Traffic Areas: Portland cement concrete box and box cover, light duty.
 - 2. Traffic Areas: Portland cement concrete box and box cover or steel or cast iron cover, heavy duty, both box and cover to be rated for AASHTO H20 loading.
- 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. Associated Concrete Products, Inc. (Santa Ana, California) (Tel. 714-557-7470).
 - 2. Brooks Products Inc. (El Monte, California) (Tel. 818-443-3017).
 - 3. 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 approved equal.
- E. Force Main Piping Access Openings:
 - 1. General: As indicated.

2.3 JOINT SEALANT FOR STRUCTURES AND MANHOLES

- A. Mortar: Caltrans Standard Specification Section 51-1.135.
 - 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.
 - 1. Rubber Gaskets: ASTM C443.
 - 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 approved 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.
 $L = 0.0002 \times D \times H^{1/2}$
L = Allowable leakage, gallons per minute.
D = Depth of manhole from top to bottom, feet.
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.
 - 6. 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 manufacturers 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 334000
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 312333 – Trenching and Backfilling
- B. Section 320523 – Cement and Concrete for Exterior Improvements
- C. Section 334600 – Subdrainage

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 74: Cast Iron Soil Pipe and Fittings.
- 2. A 615/A615M: Deformed and Billet-Steel Bars for Concrete Reinforcement.
- 3. C 443: Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- 4. C 564: Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- 5. C 1173: Flexible Transition Couplings for Underground Piping Systems.
- 6. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- 7. D 2235: Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and fittings.
- 8. D 2321: Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- 9. D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- 10. D 2751: Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- 11. D 3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- 12. D 4101: Specifications for Propylene Injection and Extrusion Materials.
- 13. F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- 14. F 656: Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- 15. F 679: Specification for Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.
- 16. F-1336: Poly(Vinyl Chloride) (PVC) Gasket Sewer Fittings.

C. AWWA:

- 1. C104: Cement Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
- 2. C105: Polyethylene Encasement for Ductile-Iron Pipe Systems.
- 3. C110: Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water.
- 4. C111: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- 5. C150: Thickness design of Ductile Iron Pipe.
- 6. C151: Ductile-Iron Pipe, Centrifugally Cast, for Water.
- 7. C153: Ductile-Iron Compact Fittings for Water Service.
- 8. M41: Ductile Iron Pipe and Fittings.

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.
9. Plan D97G: Corrugated Metal Pipe Coupling Details No. 7, Positive Joints and Downdrains.
10. Plan D98A: Slotted Corrugated Steel Pipe Drain Details.
11. Plan D98B: Slotted Corrugated Steel Pipe Drain Details.

1.4 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials.
- B. ABS: Acrylonitrile-butadiene-styrene.
- C. ASTM: American Society for Testing Materials.
- D. AWWA: American Water Works Association.
- 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 Division 1.
- 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 PIPING MATERIALS

- A. Reinforced Concrete Pipe: Designated by Class, rubber gasketed joints.
 - 1. Circular Reinforced Concrete Pipe: Caltrans Standard Specification Section 65-1.02A(1). Class III.
 - 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.
 - 4. Rubber Gasketed Joints: Caltrans Standard Specification Section 65-1.06.
- B. PVC Pipe and Fittings, 4-Inch and Larger
 - 1. Pipe:
 - a. 4-inch through 15-inch: ASTM D 3034, SDR 26. Bell and spigot joints.
 - 2. Fittings:
 - a. 4-inch through 27-inch: ASTM F 1336.
 - 3. Joint Gasket: Elastomeric seal, ASTM F 477.

2.2 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 320523 – Cement and Concrete for Exterior Improvements

2.3 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 320523 – Cement and Concrete for Exterior Improvements
- C. Precast Structure: Rate for AASHTO H20 loading in traffic 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), or approved equal.
- 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.
 - 3. Rate for AASHTO H20 loading in traffic areas.

2.4 MANHOLES AND CLEANOUTS

- A. See Section 330516 – Utility Structures.

2.5 POLYMER-CONCRETE TRENCH DRAINS

Not Used.

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 312333 – 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 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 openings at the end of each days 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 312333 – 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

Not Used.

3.6 CONCRETE OR PLASTIC FLARED END SECTION INSTALLATION

Not Used.

3.7 TESTING

- 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 334600
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 312333 – Trenching and Backfilling
- B. Section 330516 – Utility Structures
- C. Section 334000 – Storm Drainage Utilities

1.3 RELATED DOCUMENTS

- A. AASHTO:
 - 1. M 252: Corrugated Polyethylene Drainage Tubing.
 - 2. M 278: Class PS 50 Polyvinyl Chloride (PVC) Pipe.
 - 3. M 288: Geotextiles Used for Subsurface Drainage Purposes.
 - 4. M 294: Corrugated Polyethylene Pipe, 12- to 24-in. Diameter.
- B. ASTM:
 - 1. C 1173: Specifications for Flexible Transition Couplings for Underground Piping System.
 - 2. D 448: Classification for Sizes of Aggregate for Road and Bridge Construction.
 - 3. D 1621: Test Method for Compressive Properties of Rigid Cellular Plastics.
 - 4. D 1785: Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - 5. D 2235: Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and fittings.
 - 6. D 2321: Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - 7. D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 - 8. D 2729: Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - 9. D 2751: Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
 - 10. D 3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - 11. D 4716: Test Method for Constant Head Hydraulic Transmissivity (in-Plane Flow) of Geotextiles and Geotextile Related Products.
 - 12. F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - 13. F 656: Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 - 14. F-1336: Poly(Vinyl Chloride) (PVC) Gasket Sewer 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.
- C. AWWA: American Water Works Association.
- D. 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 Division 1.
- B. Product data for the following:
 - 1. Perforated pipe and fittings.
 - 2. Solid pipe and fittings.
 - 3. Prefabricated composite drainage panels.
 - 4. Geotextile fabrics.
- 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 PERFORATED WALL AND SOLID WALL PIPE

- A. PVC pipe and Fittings: Smaller than 4-inch, ASTM D1785, Schedule 40. Solvent cement joints.
 - 1. Solvent Cement: ASTM D 2564. Include primer according to ASTM F656.
 - 2. Perforation Size, Location, and Spacing: ASTM D 2729.
- B. PVC Pipe and Fittings:
 - 1. Pipe: 4-inch through 15-inch, ASTM D 3034, SDR 35. Bell and spigot joints.
 - 2. Perforation Size, Location, and Spacing: ASTM D 2729.
 - 3. Fittings: ASTM F 1336.
 - 4. Joint Gasket: Elastomeric seal, ASTM F 477.

2.2 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.

2.3 CLEANOUTS

- A. See 330516 – Utility Structures.

2.4 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).
 3. Multi-Flow (Prinsburg, MN) (Tel. 800978-8007).
 4. Phillips Fibers Corporation (Greenville, SC) (Tel. 800-845-5737).

2.5 SUBDRAIN MATERIAL FOR KEYWAYS

- A. Caltrans Permeable Material: Conform to Section 68-1.025 of Caltrans Standard Specifications.
 1. Class 2

2.6 SUBDRAIN MATERIAL FOR STORMWATER TREATMENT AREAS

- A. Washed, open graded crushed stone, or crushed or uncrushed gravel.
- B. 100 percent passing 1-inch sieve
- C. 82 percent passing ¾-inch sieve
- D. 2 percent passing ½-inch sieve
- E. 1 percent passing 3/8-inch sieve
- F. Sand: Conform to Section 19-3.025B of Caltrans Standard Specifications.

2.7 FILTER FABRIC

- A. When required, use filter fabric for encasing permeable material around subdrains.
 1. Caltrans Filter Fabric: Section 88-1.03 of Caltrans Standard Specifications.
 2. Mirafi 140N (Mirafi Inc., Charlotte, NC) (Tel. 800-438-1855) or approved 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 drainage 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 312333 – Trenching and Backfilling, and Section 334600 – 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